THE MAGAZINE OF VISUAL COMPUTING

NUMBER THIRTY-EIGHT/4.95

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The VRML-Animated "Flook"

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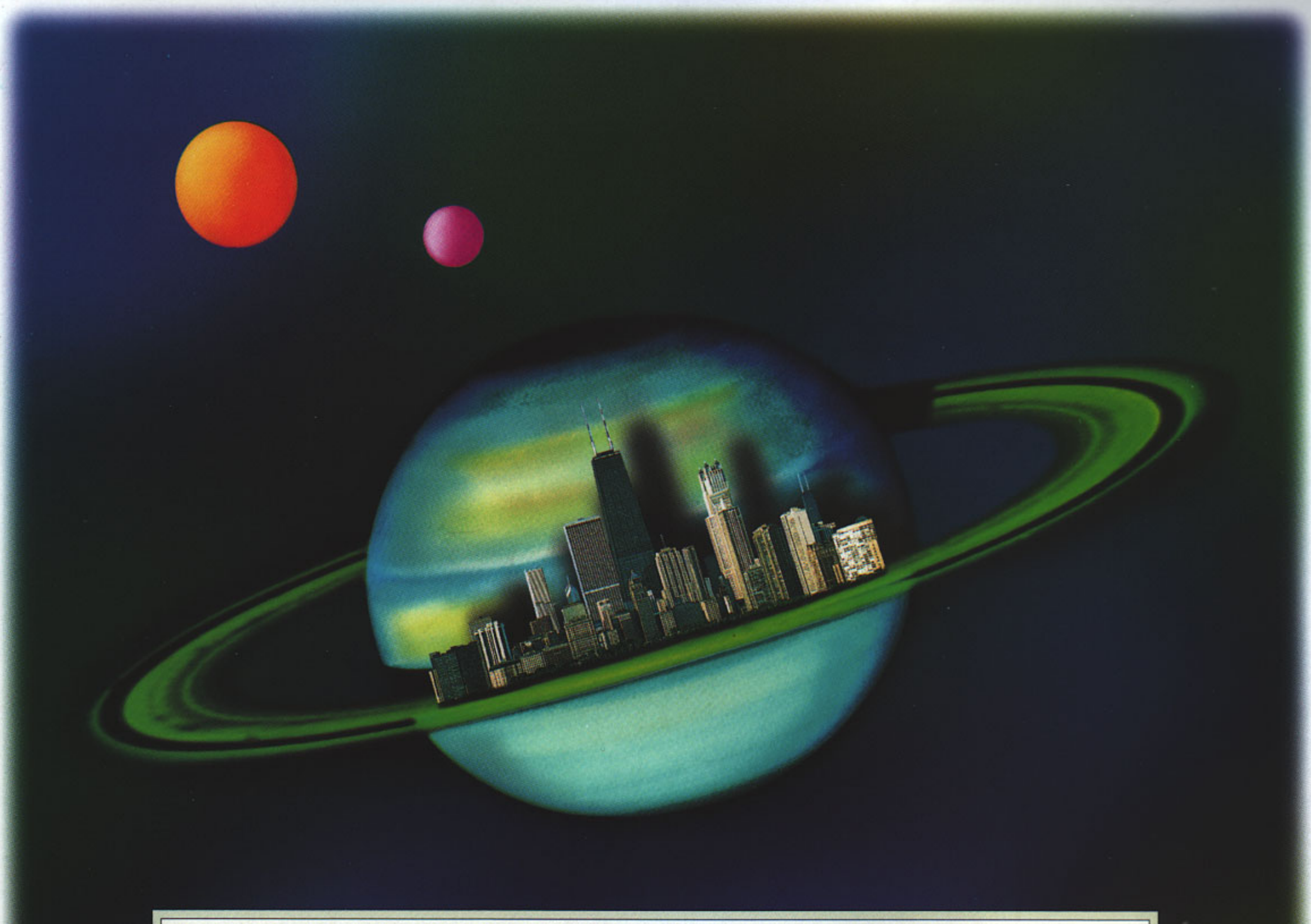

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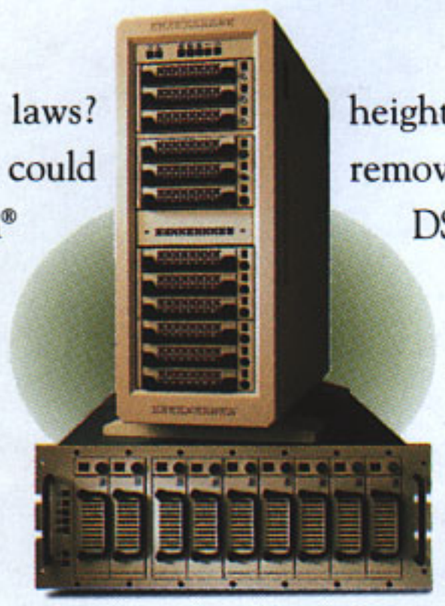

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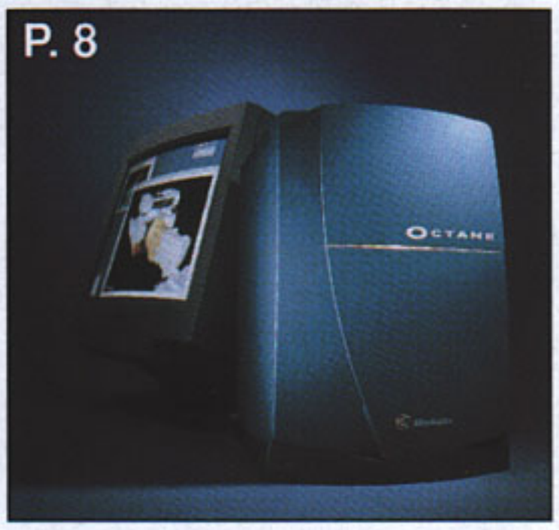

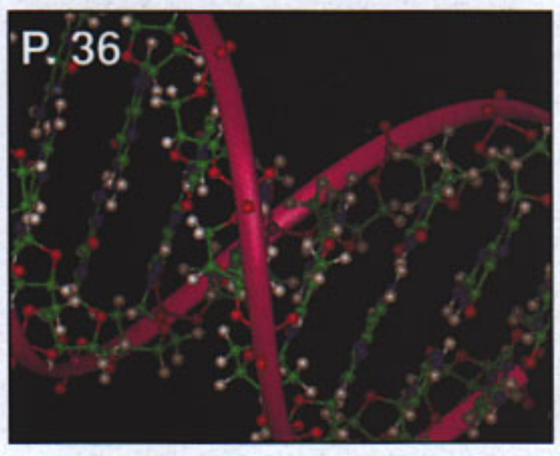

ON THE COVER: Our cover features the VRML character "Flook" (see page 65) proudly displaying the new OCTANE workstation (see page 8). "Flook" was created by Protozoa (http://www.protozoa.com) and Silicon Graphics (http://vrml.sgi.com). Engine screen image courtesy of Parametrics Corporation.

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BUSINESS OPERATIONS CONSULTANT Jim Grasham

GUEST EDITOR Reva Basch

TRAFFIC COORDINATOR Allison Pittman

DEPARTMENT EDITORS Tom Davis
Linda Jacobson

ASSISTANT EDITOR Eileen Tinney

COPY EDITORS Cristal Guderjahn
Mary-Mia Meneely
Tamara Raskin

PROOFREADER Colleen Duncan

EDITORIAL CONSULTANT Douglas Cruickshank

ART DIRECTOR Casey Mallough
graphicase@aol.com

COLOR SEPARATIONS PrepSAT

PRINTING Brown Printing Co.

EDITORIAL
Silicon Graphics, Inc.
2011 N. Shoreline Blvd. Mail Stop 415
Mountain View, CA 94043
(415) 933-2022 Fax: (415) 933-0408

CIRCULATION
Silicon Graphics, Inc.
2011 N . Shoreline Blvd. Mail Stop 415
Mountain View, CA 94043
(415) 933-6502 Fax: (415) 933-0408
e-mail: universe@corp.sgi.com
WWW: http://www.sgi.com/Technology/Publications/iris_universe.html

ADVERTISING

Southern California
Patrick Jagendorf, 10231 Slater Avenue, Suite 211
Fountain Valley, CA 92708
(714) 962-1575 Fax: (714) 968-3851

Northern California
Rudy Wagner, 2336 Harrison Street, Oakland, CA 94612
(510) 832-6300 Fax: (510) 832-6302

Mountain
Cynthia Hoffstaetter, 6730 Flagler Road
Fort Collins, CO 80525
(970) 223-3911 Fax: (970) 223-3991

Northwest
Jim Olsen, 329 S.E. Third Street, Hillsboro, OR 97123
(503) 640-2011 Fax: (503) 640-3130

Southwest
David Hoierman, 329 Oaks Trail, Suite 120
Garland, TX 75043
(972) 226-0691 Fax: (972) 226-0695

Midwest
Charles F. Minor, P.O. Box 207, Algonquin, IL 60102
(847) 854-1666 Fax: (847) 854-1672

Northeast
Charles E. Lynch, 61 Adams Street, Braintree, MA 02184
(617) 848-9306 Fax: (617) 848-2063

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KEYNOTE

Net Worth

For a book project last year, I interviewed three dozen Internet pioneers and virtuosos—scientists, software designers, Webmasters, consultants, researchers, teachers, librarians. I asked each of them what this electronic environment had to offer that their other professional tools and technologies did not. The answer, almost unanimously, was "communication." Communication with other people, communication of complex ideas through 2D and 3D models as well as text, communication, as opposed to isolation, as a way of working, learning, living one's life.

The Net, and in particular the World Wide Web, has changed not only the nature of computing, but how we think about the world. The Web is a showcase for cutting-edge technologies, a new medium for corporate marketing and advertising. And yet everyone can play; at its heart, the Web is about democracy, innovation, and fresh ideas.

It's easy to forget that desktop computers have only been commonplace for a decade, at the outside. For those of us who have been working with computers all along—in business and finance, engineering and manufacturing, scientific research, entertainment, or any number of other applications—the Web hit with the force of a tsunami. We're still riding the first crest of that enormous wave, doing our best to keep our balance while we try to figure out where it's taking us.

Silicon Graphics is deeply involved in all the areas currently undergoing this Web-propelled sea-change—from on-line shopping and interactive games to corporate intranets, collaborative design and manufacturing, distributed training and customer support, publishing, marketing, and advertising—and perhaps, before the millennium is too far along, the way we elect our public officials. This issue of *IRIS Universe* was planned and produced in the hope of providing a glimpse of what's happening now, and what we might expect in the very near future.

As an outside editor, I'm enormously grateful for the professionalism and good humor of Jim Grasham and the *IRIS Universe* staff, who know this territory much more thoroughly than I do. The Net brought me the opportunity to work with them. We, in turn, hope it brings you new opportunities as well.

Reva Basch
Aubergine Information Services

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A Desktop System for the Next Stage of Visual Computing

The OCTANE workstation eliminates historic bandwidth restrictions and radically redefines performance on the desktop

by Steve Geissen

In 1965, when Dr. Gordon Moore predicted that transistor densities on a single computer chip would continue to double every two years, it wasn't exactly front page news. But in recent years, Moore's Law—and the rapid increase in microprocessor performance during this decade in particular—have certainly received their fair share of ink in the press.

Those who keep abreast of technology trends are reminded that microprocessor performance has experienced a remarkable and rapid increase over the last decade.

Approximately every five years the industry has seen a tenfold increase in processor power. Dramatic price/performance improvements have given the average business and home user affordable access to a class of powerful computer systems that, just a few years ago, were almost exclusively available only to the technology industry elite.

This steady increase in microprocessor performance has been hailed in the mainstream press as an achievement that would radically change computing as we entered the 21st century. Unfortunately, a dark lining began to appear within the brilliant white microprocessor cloud. System bandwidth, increasing only about two times every four years, was not keeping pace with the improvements in microprocessor performance. As a result, the gap between microprocessor performance and system bandwidth significantly began widening in recent years.

This performance gap meant that the speed and interactivity of computer applications was limited not by the processor's or graphics accelerator's ability to process data, but by the computer's ability to move the increasingly large amounts of data around the system that the new high-performance applications require.

Breaking the Bandwidth Bottleneck

Silicon Graphics systems have historically led the way in graphics processing innovation, while its software providers have enabled increasingly powerful 3D modeling, animation, and digital media applications. Because of this, Silicon Graphics was quick to recognize and address this growing gap.

The company responded in October 1996 by launching a broad product line that incorporated the Unified Memory Architecture (UMA) in its new O2 desktop workstation, and S2MP (Scalable Shared-memory MultiProcessing) architecture in its WebFORCE server, Origin server, and Onyx2 visualization supercomputer product lines.

Silicon Graphics followed this launch with the announcement that it was also bringing S2MP to the desktop in the form of the OCTANE workstation, which will eventually replace the company's Indigo2 IMPACT workstations.

The S2MP architecture of OCTANE replaces the traditional shared bus—which has been at the heart of traditional computer architectures worldwide since the 1950s—with an innovative crossbar switch. This crossbar switch uses advanced packet switching technology to route messages directly from one processing element of the computer—such as the CPU—to another, such as the graphics system. Silicon Graphics' implementation of crossbar technology is a true non-blocking crossbar that allows multiple streams of data to completely and independently flow from one point to another so the streams do not interfere with or block each other.

The OCTANE workstation uses dedicated hardware processing elements to optimize primary tasks such as graphics processing or video compression. Each of these dedicated engines resides on a different arm of the crossbar switch so data can flow along a "private line" that allows every element to directly communicate with other elements.

The system's application software breaks up the tasks that need to be accomplished and assigns each to the appropriate processing element.

The OCTANE workstation also delivers multiprocessing on the desktop by supporting up to two CPUs. Thus, computing tasks can be split between the two processors and be executed twice as fast.

True one-to-one data links between major system components has been a long-awaited achievement in computing. This allows the data transfer rate to be dramatically increased.

Dr. John Mashey, director of systems technology and corporate research at Silicon Graphics, believes the development of the S2MP architecture could indeed be

viewed as a computing landmark. He compares the new technology with inventions such as UNIX, virtual memory, and RISC.

"I've been in computing since the punch card days," Mashey says. "This achievement is big. It's the biggest thing I've seen in 30 years of working in the computer industry."

Bringing a New Wave of Computing to a Variety of Industries

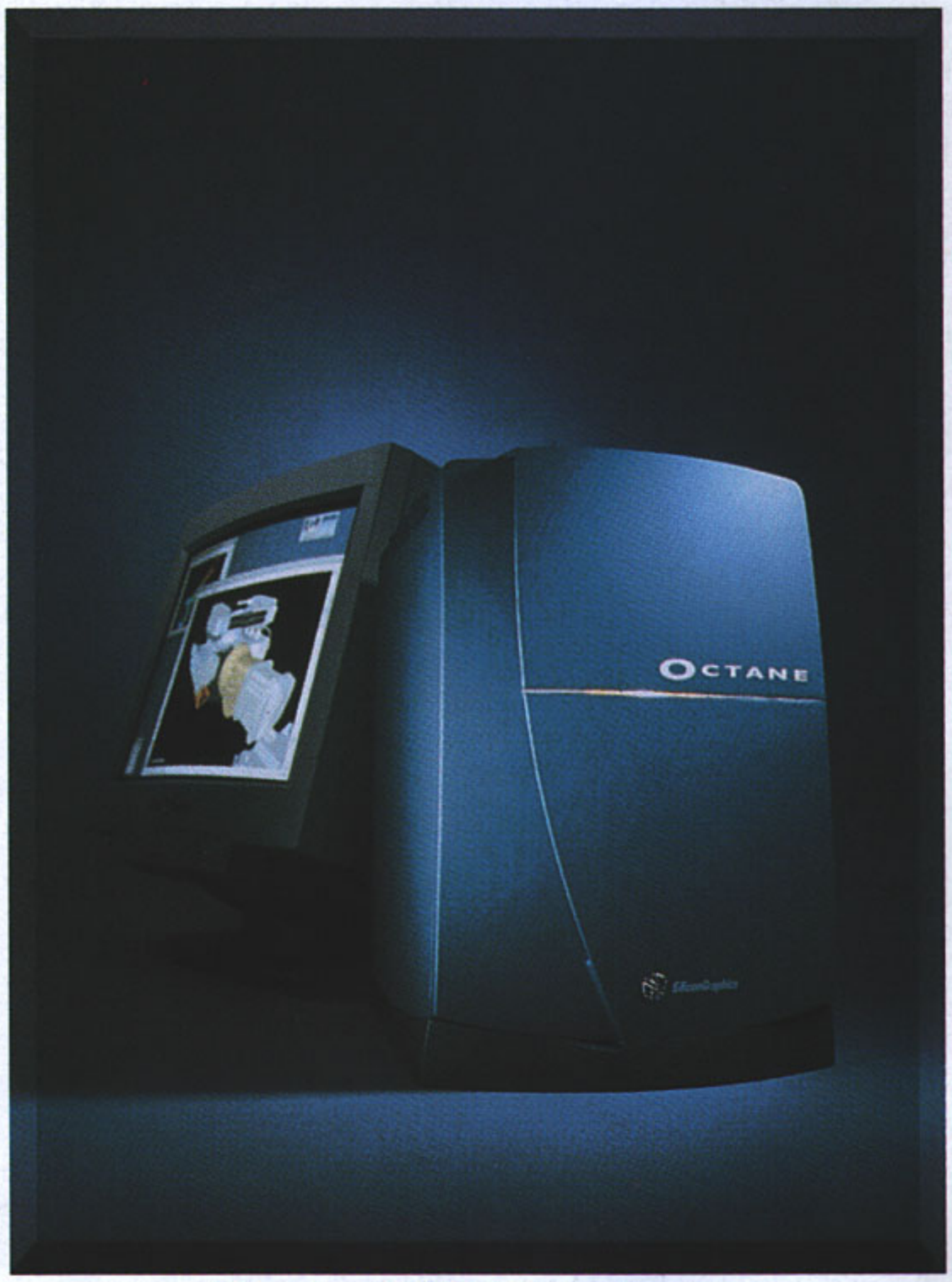
The OCTANE system is expected to have a dramatic technological impact in a number of industries.

"OCTANE provides the most powerful performance you can get on the desktop," says Tom Gillis, product manager. "It is the first implementation of a true one-to-one crossbar on the desktop. We have these hot new chips such as MIPS R10000, and you need a radical approach to feed data to them and enable them to reach their potential. OCTANE is designed to squeeze every bit of performance out of our company's most advanced hardware components.

"In the animation market, when we run Maya software (from Alias|Wavefront) on OCTANE we are seeing speed-ups on the order of 25 to 50 percent over an Indigo² workstation, which is a very powerful system. So that gives you some idea of the power of this new architecture."

In the 3D animation market, customers will be able to use the multiprocessing power of OCTANE to enable interactive photo-realistic rendering. This capability allows users to interact with and animate models on one processor, while viewing a final rendered version in a separate window on the screen.

"In the past, animators had to animate a sequence, then fire off a test render and wait for that to come back," Gillis says. "Then they'd make another change, fire off another test render and wait again. Now, with OCTANE, animation professionals can make this process totally interactive. As they move an arm or do some inverse kinematics, they can look into the window and see what's changing."



The New OCTANE workstation.
Engine screen image courtesy of Parametrics Corporation.

OCTANE will also have a major impact in the manufacturing markets. Manufacturers can use one processor to drive the interactive design phase, while the other runs advanced analysis codes.

"Manufacturing companies want to do more and more of their development process digitally," says Gillis. "OCTANE is a perfect fit for this market because it provides unequaled solid modeling performance. At the same time, it can run the kind of analysis codes that have been limited to supercomputers in the past. By doing both concurrently on the same system, you can greatly streamline the development process."

In the broadcast arena, OCTANE provides the bandwidth to deliver uncompressed non-linear editing with a guaranteed frame rate. "OCTANE can stream video from disk into our graphics subsystem, blend two streams of video together into one, then capture the results and store it back to disk," says Gillis. "This allows for real-time editing of uncompressed video, a solution that is going to be extremely competitive with the black-box solutions in this market. But OCTANE is at a price point that is getting down to the high-end Mac and PC prices."

The Bottom Line: Performance

OCTANE will also enable major innovations in markets such as oil and gas, medical imaging, and scientific visualization, Gillis says. OCTANE is perfect for fields in which professionals must load, manipulate and process extremely large data sets. The huge bandwidth capabilities of this machine will enable a much higher level of performance on the desktop.

Gillis reports that OCTANE achieves a 60 percent performance boost in floating-point performance over Indigo² IMPACT 10000 systems. The megabyte-per-second bandwidth rating is about 10-times greater than that offered by Indigo² IMPACT systems. The OCTANE line offers clock speeds of 175MHz and 195MHz.

As for how OCTANE compares to Windows NT systems, Gillis says, "People buy Silicon Graphics for performance. The current data we have on Indigo² systems versus NT systems shows an enormous

performance gap—increases over NT by factors of two, three, five, and even ten depending on the system you're comparing it to. And OCTANE will widen that gap even further.

"At the same time, we recognize that NT is becoming an established part of most major corporate computing environments. Silicon Graphics systems can be easily incorporated into environments that include NT, Windows, and Macintosh systems. SoftWindows provides emulation capability that lets users run Windows applications with excellent performance on our systems."

OCTANE preserves binary compatibility with all other Silicon Graphics systems. Numerous software providers have certified their code to realize the benefits of the new system. Silicon Graphics also has been working with its software providers to develop optimized and differentiated OCTANE solutions.

Silicon Graphics has released three new video products for OCTANE. OCTANE Personal Video Board enables multimedia content creation for the Web, videoconferencing, and collaboration. It comes bundled with a digital O2 cam.

OCTANE ProVideo card provides two streams of real-time CCIR-601 digital video into and out of the system. The board also offers video processing capabilities that enable leading video solutions.

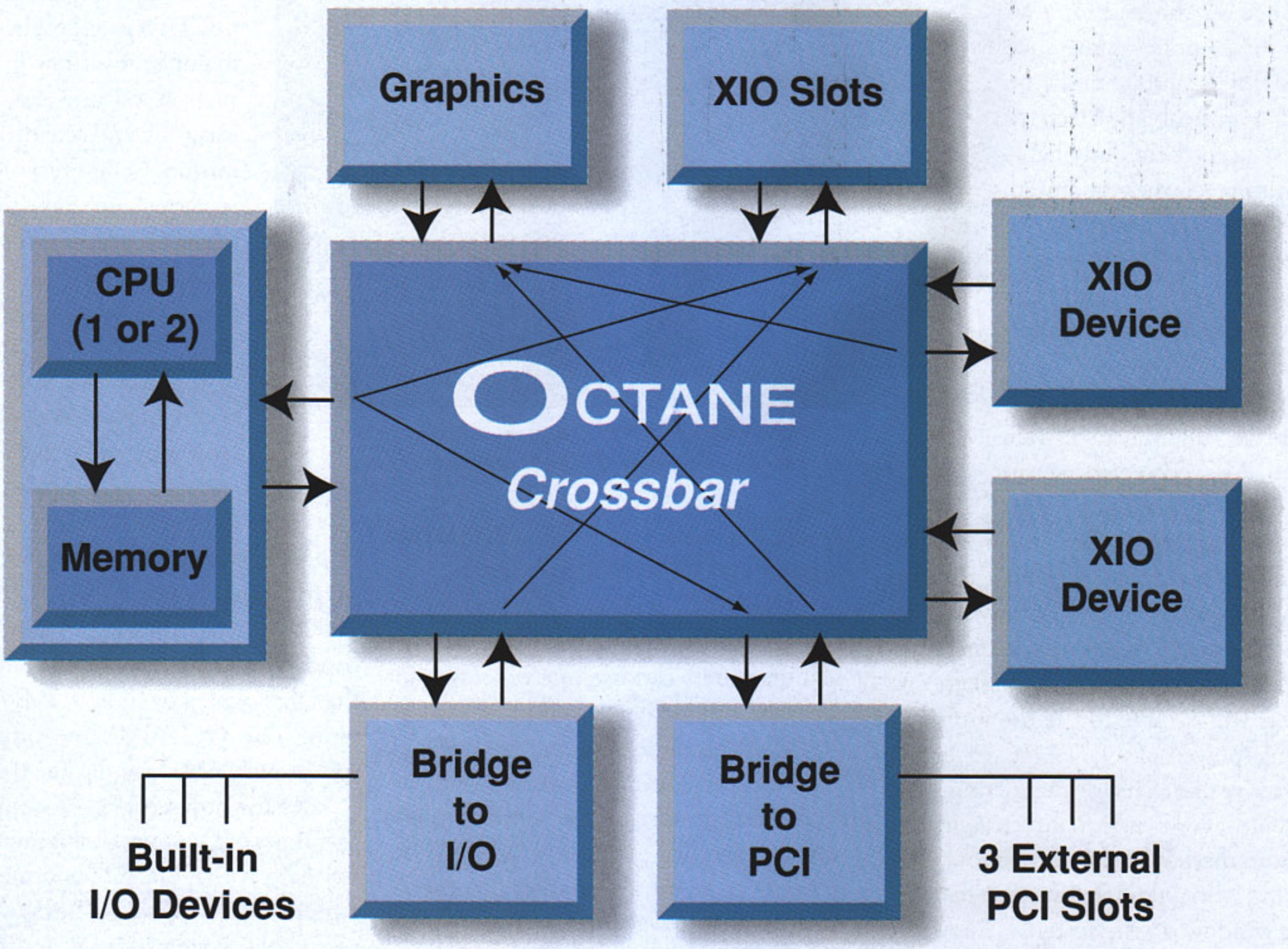
The OCTANE Compression card provides two streams of JPEG compression. This board can be used with the OCTANE ProVideo card or by itself.

OCTANE will also support a second full-resolution 3D graphics head as well as a multichannel output for immersive visualization and virtual reality. The system can be ordered with a high-resolution flat panel display. Used in conjunction with an overhead projector, the image can be displayed on a screen.

The OCTANE system ships with the IRIX 6.4 operating system, which optimizes its new features. Silicon Graphics has been working with its software providers to ensure that most major applications are certified and optimized for IRIX 6.4. The new OS is a threaded operating system and supports POSIX threads for multiprocessing application programs.

The system also includes all the intuitive Web authoring and collaboration tools that are incorporated into the company's new O2 workstation. The Web-infused desktop of OCTANE offers advanced tools for searching the Web, plus a Web publisher and server, and the capability to work with Web pages just as one would store and distribute regular files.★

Steve Geissen (geissen@phoenix.net) is a freelance writer specializing in technology. His articles on subjects such as the Web and computer technology have appeared in various national and international publications.



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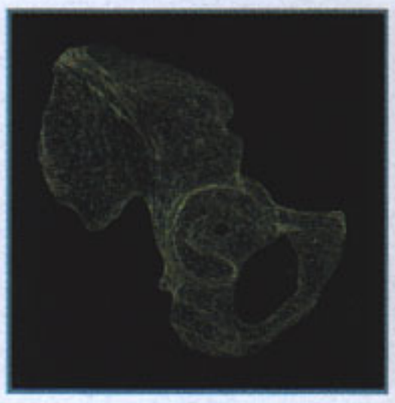
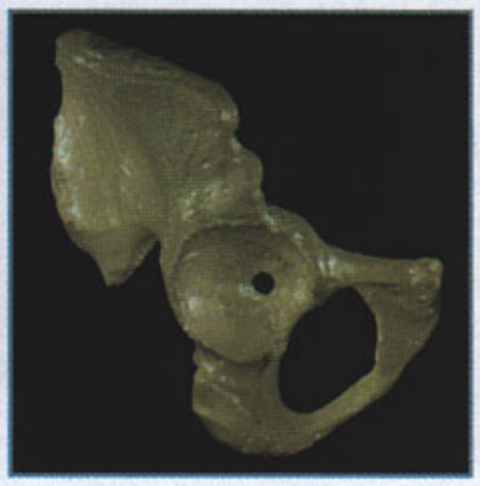
Jason's Head –
Live subject. **Cyberware 3030RGB/PS Scanner**. Converted to DXF. Smoothed and rendered in 3D Studio. 15 minutes.



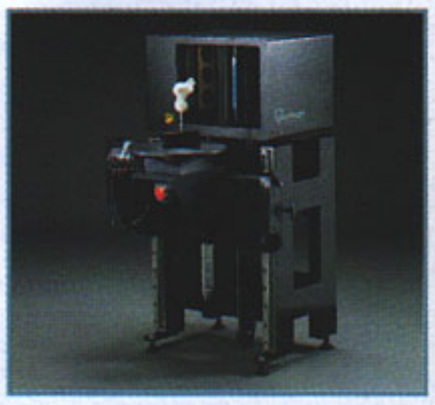


Hip Bone –
Zippered multiple scans. High resolution polygon model. Rendered in 3D Studio.

Tea Pot –
Cyberware 3030RGB/MS Scanner. Multiple scans combined into point cloud. Shown is creation of NURBS surface using Imageware's Surfacer.

NURBS Nude –
Live subject. **Cyberware WB4 Body Scanner**. NURBS surface from point cloud. Surfacer software.

Eros Kissing Psychi –
Cyberware 3030RGB/HIREZ/MM Scanner. Polygon mesh surface. Courtesy Archeological Museum of Cyprus, Higher Technical Institute, Hellenistic Period 300 B.C.



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MIPS Technologies, Inc.

Powering the Digital Revolution

by Grant Ellis

A few short years ago, MIPS was not a name that was widely known. It was (and is) an acronym standing for Million Instructions Per Second, a measurement of computer processing speed. Now MIPS stands for something else as well: a company that is driving a revolution. MIPS Technologies, a division of Silicon Graphics, designs the microprocessor technology that makes the interactive digital revolution possible.

We can trace the path of the revolution as follows: first computers had separate media components starting initially with a sound card. Then we moved into multimedia, which combines audio, video, and 2D and 3D graphics, but each in its own analog or digital format and handled by a separate chip or subsystem. We have now moved into interactive media, which requires the integration of all media types in digital formats plus high-speed communications. The next step, already well underway, is immersive interaction (virtual reality), which integrates 3D graphics and video in the same frame to create a unique real-time experience for every user. This is a bona fide technology revolution.

Putting this rich mix of video, audio, and graphics into digital format opens up limitless creative possibilities. Sound and images can be mixed, matched, and combined on-screen. All the media are now compressible, so they can be stored, transmitted, and viewed more efficiently. They can be encoded to make the content secure. But for all of these benefits to be realized cost-efficiently, the industry needs a microprocessor chip designed to handle interactive media.

MIPS: A Worldwide Presence

MIPS partners shipped approximately 17 million microprocessors worldwide in 1996. MIPS RISC (reduced instruction set computing) processors power an amazing range of products, from the world's most powerful supercomputers to leading consumer electronics products, such as Nintendo 64, Sony PlayStation, WebTV, and EchoStar Digital Satellite Receivers. "No other chip architecture spans this range," says Derek Meyer, worldwide director of marketing and sales for MIPS Technologies.

MIPS designs and licenses the industry's leading RISC processor technology to its semiconductor partners: Toshiba, Integrated Device Technology, Inc., LSI Logic Corporation, NEC Corporation, Philips Semiconductor, Quantum Effect Design, and NKK Corporation.

These partners provide millions of processors to the consumer and embedded markets. MIPS RISC processors also drive computer systems from NEC, Tandem, Siemens Nixdorf, and other companies.

MIPS has been a driving force in the interactive digital revolution at all levels from its beginning. Now the company has taken significant steps to speed things up even more.

MIPS V and MIPS MDMX: Power to the Media

Silicon Graphics recently announced two new developments designed to accelerate the interactive digital revolution: MIPSV, a fifth-generation architecture for MIPS RISC processors, and MIPS Digital Media Extensions (MDMX). Together they create a breakthrough—fully integrated real-time processing of multiple streams of audio, video, and 2D and 3D graphics on a single chip. This new technology will enable a new generation of desktop capabilities, including videoconferencing and MPEG2 compression/decompression. All the elements of an interactive or immersive experience can be processed, simultaneously, on one MIPS RISC processor.

MDMX is one of two Application Specific Extensions (ASEs) announced recently by MIPS. ASEs extend the basic design of MIPS processors to adapt them to specific industry needs—in this case, interactive media.

This is consistent with MIPS' well-defined approach to its product design: provide an architecture that gives developers and manufacturers room to move, and respond to their markets individually, rather than design a chip that imposes constraints on their own product design work. You will see this diversity in the MIPS V and MDMX-based products or services that will ultimately appear, and may already be appearing, in your neighborhood, and perhaps in your own home or office: digital video disk (DVD) systems, network computers for the World Wide Web, personal digital assistants (PDAs), videoconferencing systems, or set-top boxes for satellite video reception, among others.

MIPS16: Marrying Two DSP with High-Performance RISC

MIPS16, another of the Application Specific Extensions recently introduced by Silicon Graphics, helps electronics manufacturers solve a challenging design problem: how can they improve a product's performance while keeping it low-cost?

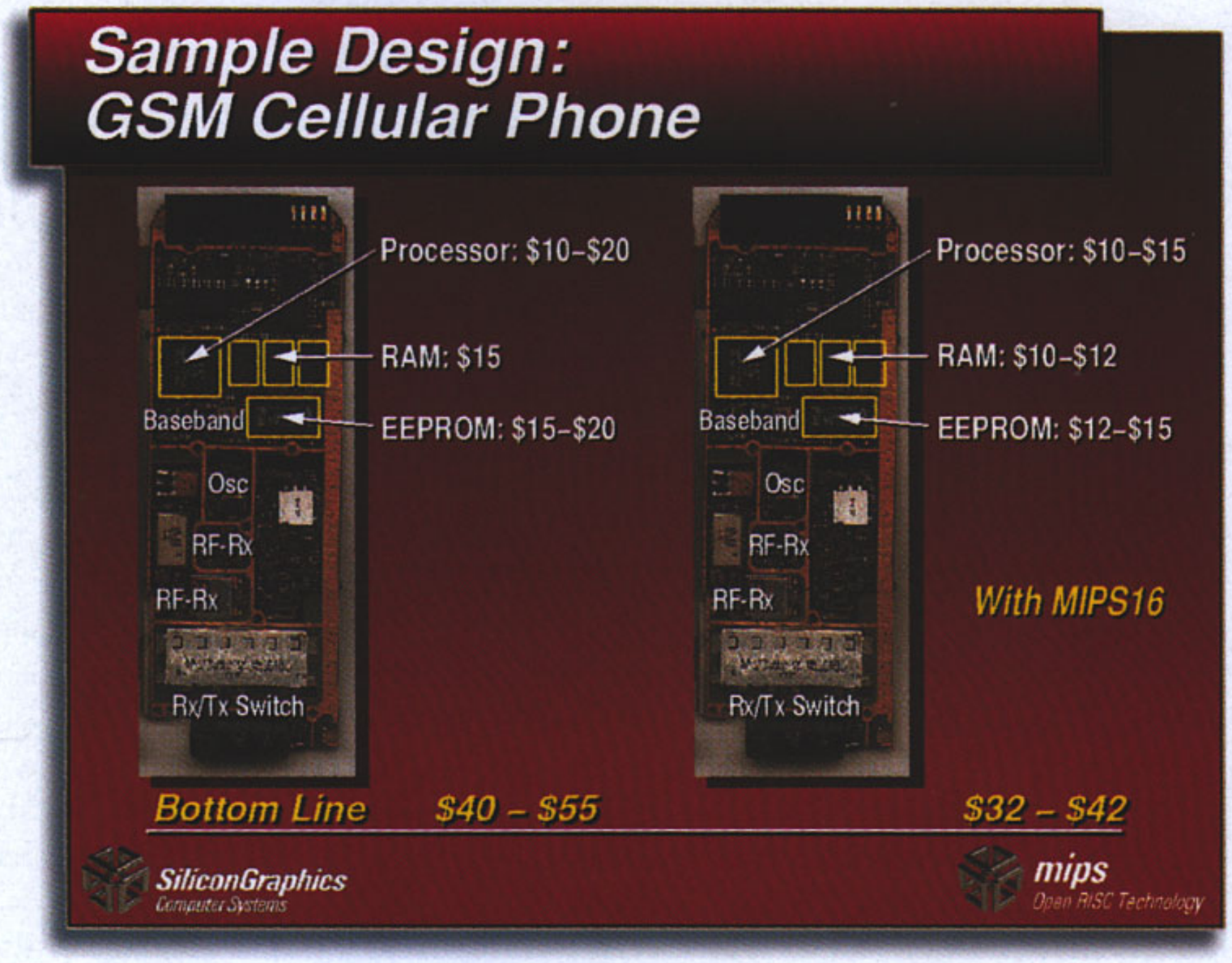
RISC processors run faster than conventional processors, but the size of embedded code running on them often requires more memory. The tradeoff is better performance. In some embedded applications (products that the end-user programs as part of normal use), the tradeoff is significant. With cellular phones, for example, battery life is an important factor. But the MIPS16 ASE gives its users the best of both worlds: the high-performance processing of MIPS RISC processors with much less code—40 percent less. Less code means less memory. Less memory means lower power, longer battery life, lower cost.

"MIPS16 presents a critical breakthrough for RISC processors into high-volume embedded applications," says Meyer. "MIPS processors have been extremely successful in powering performance-critical and media-intensive embedded applications. MIPS16 throws open the door to a new world of applications that is particularly sensitive to memory overhead costs. Manufacturers can reduce the costs of consumer and embedded products by up to fifteen percent."

To put MIPS16 in perspective, consider two competitive processors now in wide use in embedded applications. With the MIPS16 extension, a MIPS processor can deliver four-times the performance of a Motorola 68xxx (a 68EC040-40MHz, to be precise) while using only 86 percent as much code. MIPS16 also delivers eight times the throughput per watt—a significant spec for portable battery-powered devices. It delivers 13-times the performance of an Intel 486SXL-25MHz processor, with only 71 percent as much code.

This leap forward will change MIPS markets dramatically. Currently, the high-volume consumer and embedded applications for MIPS include nonportable systems like home video game systems (Nintendo 64 and Sony PlayStation), satellite television set-top receivers (such as the EchoStar DISH Network satellite receiver), network computers (such as WebTV), routers (such as CISCO), and laser printers. But MIPS16 makes MIPS processors ideal for portable battery-powered appliances like cellular phones, personal digital assistants, and personal communicators.

In a few months, MIPS processors may be closer to all of us than we imagine.



An example of cost savings in a cellular phone using MIPS16 technology.

Grant Ellis (gellis@redshift.com) writes on a wide range of technical subjects. He works from his Pacific Grove, California, home.

For the More Technically Oriented: The Nitty-Gritty

MIPS boosts its interactive digital media processing performance by combining a single instruction multiple data (SIMD) data path with an extended accumulator similar to those used in discrete DSP devices. The architecture can efficiently process multiple streams of audio, video, 2D and 3D graphics in real time. It also allows individual media types to be fully integrated into a single, combined type.

The MIPS V instruction set, a superset of all previous MIPS instruction sets, provides complete compatibility with existing MIPS software. One key addition is the introduction of the paired single data type, which doubles performance on floating-point compute applications by processing two 32-bit operands in parallel along a 64-bit data path.

MIPS V also provides significant performance increases for 3D geometry processing. It can accelerate Virtual Reality Modeling Language (VRML) applications, including those based on Cosmo OpenGL, and other visual or virtual world environments. MIPS V can be implemented on a variety of future processors developed by MIPS partners.

MIPS MDMX is separate from, but compatible with, MIPS IV and newer instruction sets. MDMX features an extended 192-bit accumulator, which gives MIPS processors true on-chip, high-performance digital signal processing (DSP) capabilities. These capabilities are important for on-chip real-time video decompression, digital auto surround (Dolby Digital (AC-3), for example), and data compression (such as fax modems require). MIPS MDMX code offers twice the DSP efficiency of other SIMD architectures, better memory performance, and more efficient register use.

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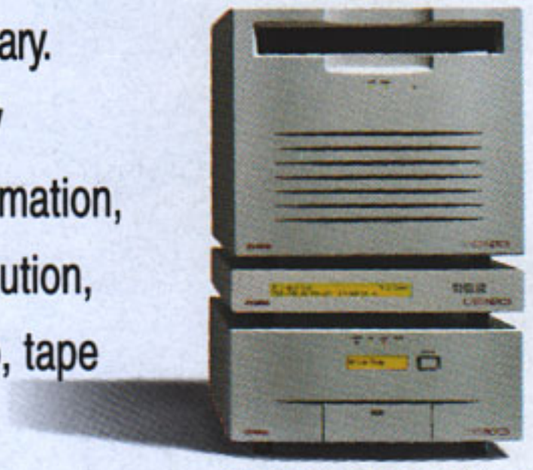

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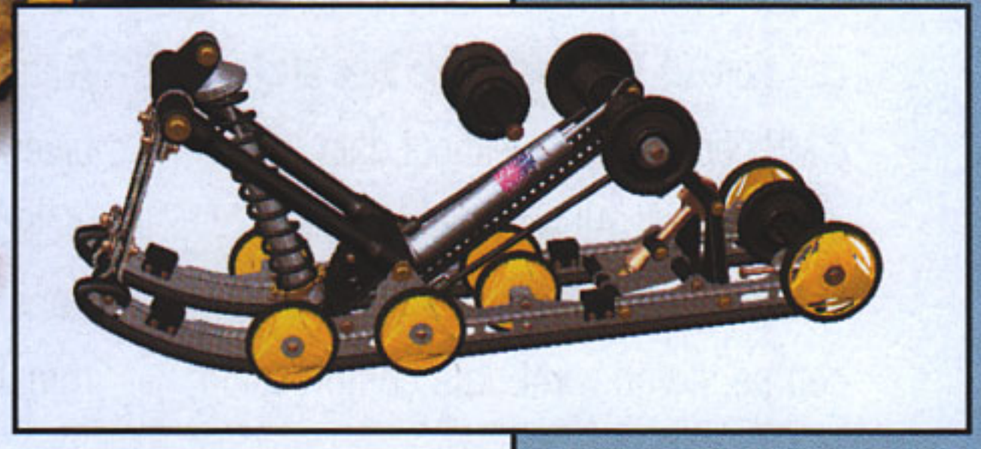

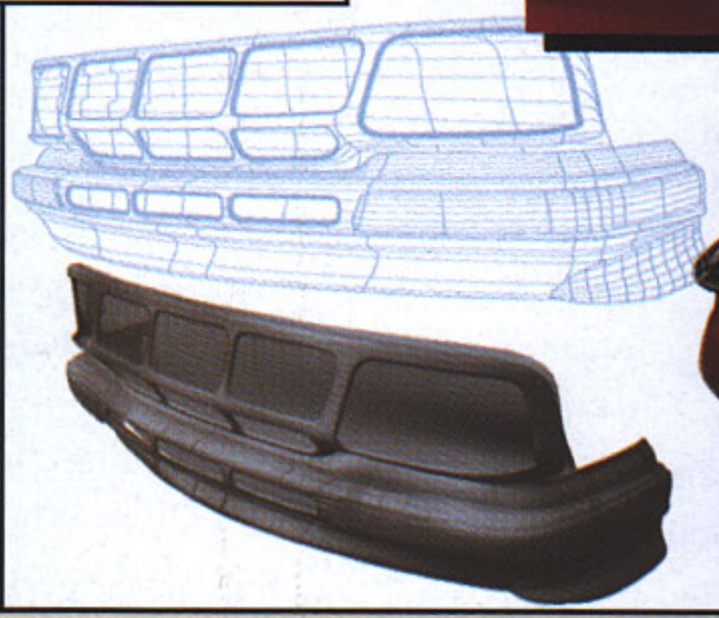

Come Here...

Electronic Communication at the Beginning of the Computer Age

by Douglas Cruickshank

"In the future, the twenty-first century—not the twentieth—will be seen as the computer-information age. I think the twentieth century will be viewed as a time of experimentation in regard to the computer, much like the nineteenth century was for the automobile."

—Edward R. McCracken,
Chairman of the Board and CEO, Silicon Graphics, Inc.

"Watson, come here; I want you."

—Alexander Graham Bell, speaking the first complete sentence transmitted via telephone, March 10, 1876

A New Language Arrives

In the 120 years since Alexander Graham Bell made that first phone call, perhaps no one has more succinctly defined the ongoing phenomenon of electronic communication, nor better summed up the appeal and benefits of being connected, than the eminent inventor did with those first few words to his assistant, Thomas Watson. "Come here," he said, and Watson was there immediately—but he was also elsewhere.

To say it was a breakthrough is both obvious and a gross understatement. Bell suddenly had a device at his command through which he could easily reach his assistant at a distant location, converse with him, benefit from his considerable knowledge, or simply extend a dinner invitation. And he could do it instantly. The telephone, as it became more sophisticated and ubiquitous, made proximity significantly less important. It made worldwide communication in real time, or near real time, a reality. It enabled the transfer of information from one human mind to another, regardless of where in the world those two humans happened to be.

Even today, however, the typical telephone cannot store the volumes of information it transmits; it can't organize data, nor work with it. But the computer can. The impact that the fusion of the current panoply of telecommunications and computing technologies is now having on culture is one of the sweeping stories of this century, and it is likely to become even more profound over the next century.

Of course, there is more to electronic communication than telephones and computers. Among the many other types of contemporary media, television is inextricably woven into our lives. The means of transmitting information (Ethernet, ISDN, fiber-optic cable, microwave, satellite, and so on) have also become more varied over the years. Still, though technology and media are converging, and the ways in which we're connected have multiplied, the notion that gave birth to an electronic network for enabling human communication on a grand scale remains the same: "Come here."

Perhaps, if Bell were around today, he might amend his remark to "Come here—or go there—and bring your work with you." Today's electronic communication in its myriad manifestations, though undeniably driven by commerce, is also a product of that other force of human nature: the need to communicate—to convey ideas (or jokes, pictures, what-have-you), to be informed, to make oneself understood, to become educated or to educate others, to collaborate—to simply make contact.

Despite the lightning-like pace at which technology has developed during this century, nothing has so galvanized person-to-person(s) electronic communication worldwide as the events of the first half of this decade—specifically, the popular embrace of the Internet and the advent of the World Wide Web. The ramifications of this new medium for business and industry are both deep and wide (use of the Internet by individuals is increasing at a rate of 42 percent a year, while more than 80 percent of the largest advertisers in the United States, England, western Europe, and Japan now have Web sites). Originally devised as a text-based communication network, the Internet—and its multimedia adjunct, the World Wide Web—will continue to flourish because we

A Self-Assembling Puzzle?

The social and philosophical forces behind the astonishingly rapid growth of the Web cannot, and should not, be discounted. Yet they're only part of the story. The Internet and intranets are fast becoming an indispensable component of business, industry, and education—from stock brokerages to television networks, from genetic research organizations to makers of on-line multiplayer games. As access becomes more widespread, and advances in the sophistication of hardware and software make electronic communication easier and more powerful, the Web, print, movies, television, and to some degree radio, are starting to be seen as a suite of complementary media moving in the direction of a single integrated medium.

From our present vantage point—a transitional period, to be sure—it seems inevitable that the Web, complemented in singular fashion by the interactivity it offers, will be the great unifier. To the casual observer, who doesn't see that the pieces are being carefully shaped to fit by brilliant minds often working late into the night, the Web might resemble a puzzle, the pieces of which jump into place by themselves as soon as someone thinks of a need. Yet it's a puzzle that we will almost certainly see completed by the end of this millennium, as computers, television, and telecommunications truly converge, and the term "media convergence" changes from buzz phrase to reality.

From our present vantage point—a transitional period, to be sure—it seems inevitable that the Web, complemented in singular fashion by the interactivity it offers, will be the great unifier.

Digital audio, video, and 2D and 3D graphics, which can now be seamlessly integrated, are enabling this convergence in the media sphere. On the hardware side, powerful new computer architectures, such as the MIPS V processor and MIPS Digital Media Extensions (MDMX), designed expressly to facilitate interactive multimedia, represent the current state of the art in the new convergence-oriented technology. Up ahead, the practical application of networked experiential computing (virtual reality) in business, entertainment, and medicine may be commonplace sooner than you think.

Underlying such dramatic innovations is the simple issue of relevance. Industry, business, and society at large are turning to the Web on an increasingly regular basis because it's relevant to what they're doing. The more they come, the more relevant it becomes. It's a symbiotic relationship; people need a place to gather as much as a gathering place needs people. As a locus of human activity, the Web is doubly relevant because it's suited to the complications, irregular schedules, and geographic distances that tend to define modern life, to say nothing of the ease with which it handles the massive amounts of digital information that now play a central part in our work, entertainment, and social communication.

Not surprisingly, the core businesses that anchor commerce in most communities—banks, stock brokerages, bookstores, travel agencies, diversified shopping malls, purveyors of food and wine, computer and software outlets—already have a major presence on the Web. As people become more accustomed to the convenience and immediacy of on-line transactions, businesses large and small will reap an estimated hundreds of billions of dollars in revenues. On-line commerce is also likely to be a beneficiary of new end-user technology that displays both computer applications and television on home theater-size monitors, making it easy for individuals or families to switch between the two—to book a flight, for example, while watching a favorite program.

As the emerging worldwide standard for computer networking, the Web so eases collaboration—between two individuals or among dozens—that it has literally revolutionized the way people work together. The staff of a print or on-line magazine can now be spread around the country or the world, submitting articles, illustrations, photographs, and layouts, making revisions, negotiating fees, and sending invoices via the Web and e-mail—and taking no more time to do it than if they were in the same room. Industrial designers, engineers, and architects can work the same way. Film and video production, advertising, product prototyping, and innumerable other undertakings can all be done by groups of people employing the Internet for collaboration.

Innovative ways of using the Web are developing with almost the same frequency as new Web sites. Silicon Graphics, for example, jettisoned the traditional approach to product launches by presenting its new product line exclusively via a live Web rollout called, logically enough, "Webcast Live." In doing so, it took an event that would normally be experienced directly by a few thousand people at most, and made it accessible to millions worldwide. Better yet, much of the material presented during "Webcast Live" is still readily available on the company's Web site, Silicon Surf. Given that Silicon Graphics technology powers many of the world's most effective Web

need it, we want it, and, ideally, it can free us—allow us to cope with the daunting complexity of our world, amplify our intellects and our efforts, and let us connect with one another in ways that are more immediate, more powerful, and potentially more democratic, than anything else that has come down the pike.

That hackneyed phrase, "come down the pike," alludes not only to one of the key differentiators of new electronic communication—the nonlinear character of the Web—but also to the "what shall we name the baby?" debate that has raged since the word "Internet" first hit the newspapers. The World Wide Web as a medium differs from others—books, movies, television—in that it is *essentially* nonlinear. From its beginning, those who have best understood its capabilities and potential have capitalized on that unique characteristic. Conventional media cannot begin to compete with the sheer scope and immediacy of the Web, not to mention its ability to constantly add to and modify its own content at a rate of speed that is approaching real time.

Thus, terms such as turnpike, road, or highway are especially inapt in regard to the Internet and the World Wide Web. They evoke the familiar image of a ribbon of asphalt which, to the user, suggests a beginning, a middle, and an end—like a book, a movie, or a television program. "Information Superhighway," too, sounds like a data expressway of some kind—a thruway that takes you from one point to another along a linear path. The Web is better envisioned as a dynamic, multidimensional space, as in William Gibson's term "cyberspace," or, better yet, "the matrix," as John S. Quarterman called it in his book, *The Matrix: Computer Networks and Conferencing Systems Worldwide* (Digital Press; 1990). Or maybe we'll just settle for calling it the Web, a reasonably good metaphor after all, as long as we remember that the Web's not flat but multidimensional, expanding outward in every direction at a rate of—what was it?—42 percent a year.

You don't travel the Web in a linear sense so much as immerse yourself in its continually evolving content, focusing on and reaching for those things that are relevant to you, your work (or play), and those with whom you're collaborating. Some Web users describe it as "wandering through information." You move through the data employing a process that can closely mimic the random manner in which a lively human mind makes associations and connects ideas. In fact, that's one of the Web's most fascinating and alluring features: it brings electronic communication closer to an organic model than anything that has come before it. Beyond the relatively basic order provided by indexes and search engines—which doesn't always add coherence to your experience—you make sense of the Web's information as you encounter and accumulate it, by virtue of the order you impose on it, much like you order your thoughts before expressing them.

Indeed, in many respects the Web most resembles a language, a language in its infancy, for which grammar is still being defined and developed. Like language, its randomness and anarchic spirit—its refusal to be owned—may be the very things that keep it vital. Surprisingly, those characteristics may also be what make it valuable to business, industry, and individuals. Businesses have found that introducing an intranet into the corporate structure can have a transformative effect on the entire company, and that a Web site can utterly revitalize an enterprise's relationship with its clients.

The nature of electronic communication is moving and changing with staggering speed. We are attempting to master this new language although we are still inventing some of its most basic elements.

The nature of electronic communication is moving and changing with staggering speed. We are attempting to master this new language—even teach it to others—although we are still inventing some of its most basic elements. We can speculate about where it will take us, though we can no more be certain at this point than Alexander Graham Bell could foresee the impact his invention would have on culture.

What we're sure of is that the Web (and related forms of electronic communication) is allowing us to communicate and work with one another in unprecedented ways. As with all inventions, however, the Web's ultimate usefulness will depend heavily on our ability to remember where we were going when we started down this road. (Given the current parameters of our thinking and language, linear metaphors seem to be inescapable.) No matter how sophisticated the technology, no matter how compelling the Web becomes as a communications medium and a business tool, the point is to make contact and to stay in touch, to collaborate, and to use this invisible world-sized device as a means of diminishing the distances between us.

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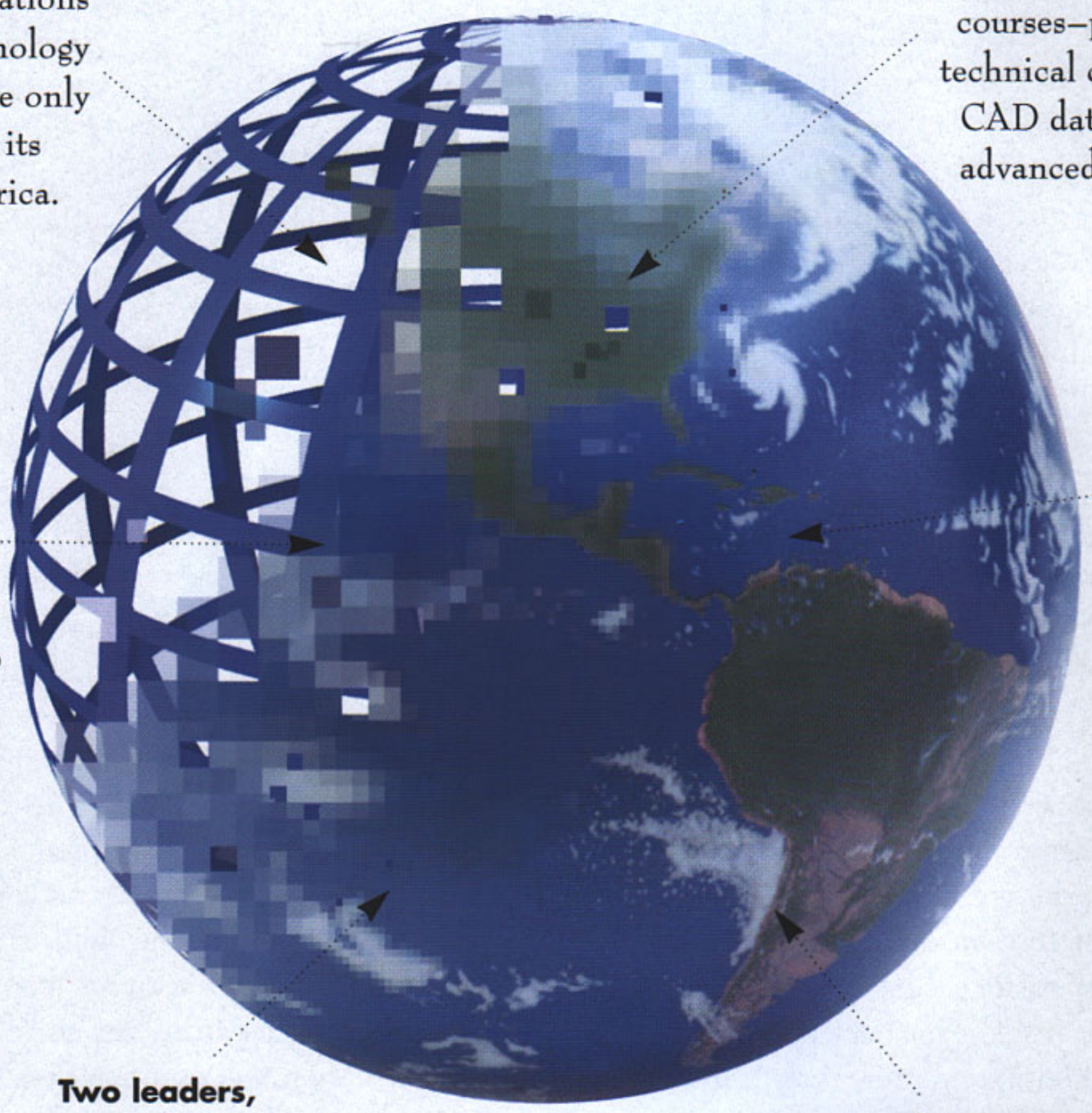

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sites and intranets, what better way to demonstrate the power and ability of the new systems than by using the Web itself?

Scientists have been Internet-fluent almost since the mega-network's inception, and some of the most promising work currently being done via the Web is in the scientific and medical arenas. Medical and scientific organizations have been at the forefront in seeing the possibilities offered by the Internet, the World Wide Web, and intranets. A few of the most prominent recent successes are the National Library of Medicine's Visible Human Project, a collection of on-line digital images depicting a complete male and female cadaver for use in medical research; the National Center for Biotechnology Information's vast public domain database of genetic information on thousands of species; and the Human Genome Project's map of the human genome. Use of the Internet and Web technology in commercial medical, research, bioinformatics, and pharmaceutical enterprises is equally widespread and sophisticated.

As the rich puzzle that is the Web swiftly becomes less puzzling, as its offerings and capabilities become richer still, its relevance becomes clear to greater and greater numbers of people.

Yet, at the end of the day, Web-enabled communication doesn't stop. On-line chat rooms and e-mail are now an established part of our social lives. Interactive 3D games, in which multiple players located around the world participate via the Internet, are one of the fastest growing sectors in electronic communication. The on-line games market is expected to reach $1.6 billion in revenues by the turn of the century, with as many as 100 million households participating. If you prefer to spend your leisure time just kicking back and reading the news, you can now choose from more than 1,400 newspaper Web sites, ranging from the *New York Times* and the *International Herald Tribune* to the *Sunday Observer* of Sri Lanka and Beijing's *China Daily*.

As the rich puzzle that is the Web swiftly becomes less puzzling, as its offerings and capabilities become richer still, its relevance becomes clear to greater and greater numbers of people. More than any previous technology or system, this new multifaceted form of electronic communication enables business, industry, and individuals worldwide to be better informed, better understood, and in closer real-time contact than ever before. And, by the way, it's fun.

The Space Beyond

"Around here we say anybody who tries to forecast the weather in West Texas is either a foreigner or a fool."

—Motel clerk, in conversation with the author, Odessa, Texas, 1972

Anyone who's driven through West Texas or similar expanses knows just how vast vast can be. Yet the great (nonlinear!) wide open space of electronic communication is considerably larger than the most well-traveled among us can imagine. Viewed within current technological and social contexts, the Web is likely to become *the* workable, effective "convergence medium." But the concept of media convergence is often misunderstood. Such a medium needn't supplant its predecessors in order to emerge as a medium in its own right—sometimes encompassing other media, sometimes employed in parallel, and on still other occasions used for its own unique capabilities.

Already, print magazines are being published that are intended to be used in direct conjunction with the Web. Authors are maintaining Web sites so they can regularly update their books and communicate with readers. The entertainment industry has been using the Web to promote and complement its productions. In the music business, the Web has given exposure to many musicians who might not otherwise have reached such a wide audience. The television and Web coverage of the recent U.S. presidential election is a sterling example of how two media can leverage each others' strengths while providing the public with unique content and perspective. As electronic communication continues to broaden its capabilities and extend its reach, applications like these will proliferate, and the Web will play an ever-greater part in business, industry, and society.

Electronic communication is changing the world and changing our lives—that much is irrefutable. Predicting what course it will finally take or what it means is no easier (or wiser) than forecasting the weather in West Texas. Will the Web be humanity's crowning communications achievement? If not, what's next? What's out past the matrix? What lies beyond cyberspace? We don't know. But in creating the Web we may very well have devised the tool that can take us there. ★

Douglas Cruickshank is a freelance writer and former editor of IRIS Universe.

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THE LAUNCH OF A NEW AGE

SILICON GRAPHICS FORGES A NEW PATH IN TECHNOLOGY MARKETING BY HOSTING ONE OF THE LARGEST WEB-BASED PRODUCT ANNOUNCEMENTS IN HISTORY

BY STEVE GEISSEN

Less than two months before Silicon Graphics would introduce the most innovative system architecture in the company's history—and a major upgrade of its entire product line—a group of key company executives met with Ed McCracken, CEO and chairman of the board, to discuss plans for the worldwide product launch.

The representatives had spent three weeks preparing launch scenarios. They presented plans describing what would essentially be a traditional worldwide launch. The launch would involve four separate components: sales training presentations to the worldwide Silicon Graphics sales force, training for indirect channels, related international events to inform customers of the new product line, and the public presentation to the press, analysts, and customers.

Webcast Live hosts Joe DiNucci, Silicon Graphics vice president of corporate marketing (above), and Gary Lauer, president of Silicon Graphics' World Trade Corporation (at right), kicked off the Web-based product launch from a studio in Cafe IRIS at Silicon Graphics headquarters in Mountain View.

The executives presented their ideas for the staging of these events. Then a brief silence filled the room. "I don't think we should do that," McCracken said. "I think we should take advantage of our systems and tools and do the launch live on the Web."

McCracken's idea was for Silicon Graphics to walk its talk. The company had been deeply involved in the evolution of the World Wide Web since its early days. Silicon Graphics WebFORCE systems power many of the world's most successful Web sites and corporate intranets. With its work in developing VRML technology, Silicon Graphics had pioneered 3D applications for the Web. Its new product line integrates next-generation Internet and intranet serving, publishing, and file transfer capabilities into the user environments. Additionally, Silicon Graphics' own intranet is widely considered to be one of the world's most advanced corporate networks of its kind.

McCracken's idea struck those assembled in the room as a perfect fit for the company and for this launch in particular. However, there was one problem: one of the most important and complex product launches in the company's history was just a few weeks away.

Despite this daunting consideration, the decision was made to conduct the launch on the Web. The company's broad new line of computers would be introduced to the press, customers, and analysts via an event called "Webcast Live." The Webcast would allow thousands of people around the world not only to see and hear the launch presentation live via the Web, but to submit questions by calling a toll-free phone number or sending e-mail during the presentation. Following the Webcast, Silicon Graphics would host Web-based forums where participants could ask additional questions about the products.

The plan also called for worldwide sales training to be conducted over the Web. The international customer events accompanying the launch would be handled much as they had been in the past. But, instead of sending representatives from

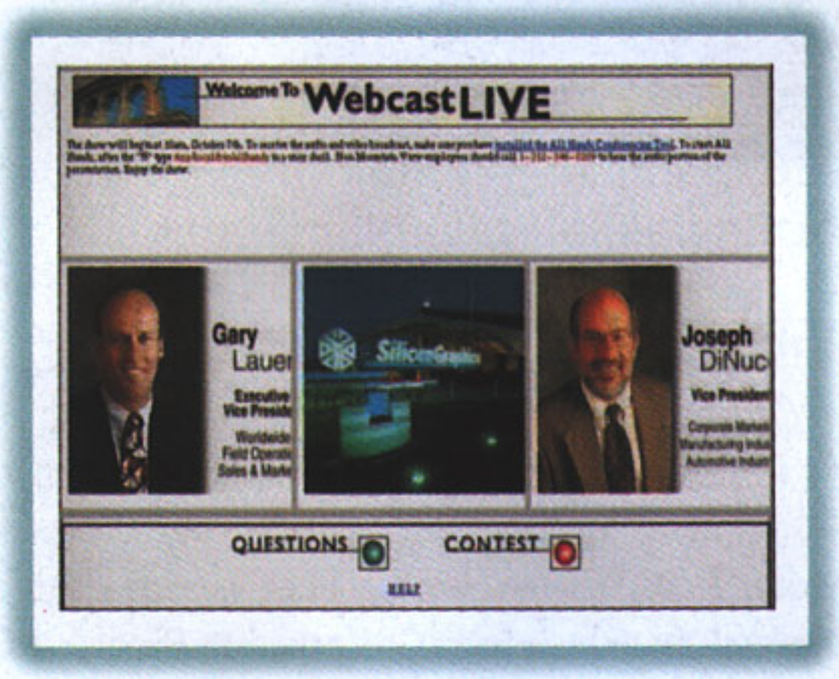
Mountain View to supply regional offices with product information, Silicon Graphics would conduct these intracompany technology briefings on the company's internal Web.

The attendees left McCracken's launch meeting inspired by the vision. The Webcast would open up new avenues for providing a wealth of information in real time to Silicon Graphics constituents around the world. The challenge would be pulling off such a major undertaking in such a short time.

ENTERING NEW TERRITORY: DEVELOPING THE TECHNOLOGY FOR "WEBCAST LIVE"

As news of the Webcast launch filtered through the company, the decision was met with both support and much questioning. Most of the skeptics liked the idea but voiced common concerns: How could Silicon Graphics prepare for such a huge undertaking in just a few weeks? Should the company attempt such an elaborate Webcast for one of the broadest and most important product announcements in its history? Could the Webcast adequately convey the technical complexity of the systems that were being launched?

These questions were considered and debated throughout the company. In the end, those responsible for creating the Webcast came to the conclusion that it could indeed be accomplished. Not only that, with the right tools, the Web was a perfect medium for conveying the complexity of the new system architectures and other features to a worldwide audience. But the company would have to move aggressively and creatively to accomplish the ambitious goals it had set for itself.



"We knew this would take an incredible team effort from everyone involved in the Webcast programs," says Mike Sherwood, manager of electronic marketing and the organizer of Webcast Live. "Considering the amount of time we had to work with, we had to move very quickly. We had to put the technology infrastructure in place and work with the divisional marketing people worldwide to incorporate the appropriate product information.

"Basically, we used existing tools to create the infrastructure. We used an in-house tool that allowed us to merge Showcase, Silicon Graphics' presentation application, with real-time audio solutions from companies such as Progressive Networks, Xing, and Graham Technology Solutions," says Sherwood. "The technology allowed us to produce a live Web presentation that updated the HTML pages every 45 seconds, so the audience would be able to hear the live launch presentation from Mountain View while looking at Web pages that presented the faces of the speakers, the new machines and their features, performance statistics, and other product information."

Silicon Graphics advertised Webcast Live on its own Web site, one of the most heavily trafficked corporate sites in the world, and on various other Web sites. It was also widely advertised in print publications in major cities, and the worldwide field offices informed customers of the event.

The launch would be one of the largest product announcements in history conducted live on the Web. The press was already calling it an event that would blaze a new trail in cyberspace marketing.

LIVE ON THE WEB: INTRODUCING NEW PRODUCTS TO THE WORLD

On October 7, Webcast Live hosts Joe DiNucci, Silicon Graphics vice president of corporate marketing, and Gary Lauer, president of Silicon Graphics' World Trade Corporation, kicked off the Web-based product launch from a studio in Cafe IRIS at Silicon Graphics headquarters in Mountain View.

"Once upon a time, if somebody in Chicago wanted to communicate with somebody in Denver, they stuck the message in a saddlebag," said DiNucci at the beginning of the Webcast. "Then somebody strung a wire and tapped a telegraph key, and the Pony Express looked pretty quaint. What we are doing today is going to make traditional product announcements quaint."

Speaking to an audience of thousands around the world who were listening to the live presentation while viewing updated Web pages presenting visual product information, the Webcast hosts went on to describe the company's new product line, which ranges from entry-level workstations to high-end scalable supercomputers and servers. The hosts also announced the company's new S2MP (Scalable Shared-memory MultiProcessing), the underlying architecture used for WebFORCE servers, Origin, and Onyx2 product lines.

DiNucci and Lauer provided detailed information about the new systems and their revolutionary new architectures, interviewed company technology and product experts, fielded ques-

tions from viewers, and conducted contests in which participants could win new Silicon Graphics products, including an O2 workstation.

Following Webcast Live, Silicon Graphics hosted Web-based forums that allowed the audiences to participate in real-time question-and-answer sessions with company product experts. Chat rooms were set up for each of the company's new products.

"The chat rooms were extremely well received," says Sherwood. "We had a lot of very good questions. Many people on the Internet are scientists and engineers, and they want the hard facts about the products. They appreciated the opportunity to speak directly to the product managers."

Sherwood says the Webcast Live presentation was beneficial in terms of disseminating quality information to Silicon Graphics constituents, and was highly educational for the Silicon Graphics participants as well.

"This was the first time we did a product launch on the Web, and we learned a lot from the experience," says Sherwood. "We learned a tremendous amount about how these things work, what we did right, and what we can do better the next time.

"There were some people who couldn't access the broadcast on the Internet. Despite our adding a number of servers to the infrastructure, some bandwidth restrictions still came into play," says Sherwood. "Obviously you want everyone who wants to come in to be able to enter the site and view it. That's certainly something we'll address the next time we do this. But on the whole, it was a very positive experience. We're very excited about the possibilities for doing future Web-based launches."

The audio and visual presentation material was maintained on the Web so that customers and others who couldn't make it to the live Webcast could access the same information at a later date.

TAKING SALES TRAINING TO A HIGHER LEVEL

The Web-based sales training aspect of the product launch exceeded expectations, says Mike Look, manager of field marketing at Silicon Graphics, who directed it.

The worldwide sales force viewed the sales training presentations on the Web. Audio was provided via a conference-calling network established for the event. Training sessions were scheduled on a region-by-region basis, with worldwide training conducted for more than 50 consecutive hours.

Conducting sales training in this manner allowed the sales force to see and hear a highly detailed presentation lasting about three hours. At the conclusion, sales representatives could review the Web presentation on the Silicon Sales Web site, which is part of the Silicon Graphics intranet.

This material included synchronized prerecorded audio as well as the visual presentation content from the sales training session. If sales representatives needed to review information on a particular product, they could access it as often as they wanted, at their convenience.

"The sales training tools on the Web worked extremely well," says Look. "The beauty of this approach is that we are continually updating the Silicon Sales Web page and adding new information to the original content. As we discover new points we would like to convey about a particular product, or as questions come in that we need to answer, we can simply update the Web page and educate the people in the field."

Look says Web-based sales training will definitely be a part of the company's direct and indirect field-training strategies in the future.

"As Silicon Graphics grows to become a $3 billion-plus company, we're going to have to devise new and better ways to provide information to a growing organization. With our Web technology, we can address more people and do it very efficiently. Had we done this the traditional way, it probably would have taken us 90 days to reach every sales representative and partner. Instead, within just two days, we were able to educate, train, and empower our entire worldwide sales force. This is certainly the wave of the future for us."

To have done comparable sales training in the traditional manner, Look says, would have cost Silicon Graphics about $3 million. The Web-based training cost the company approximately $200,000.

ADDING VALUE TO INTERNATIONAL CUSTOMER EVENTS

The international events that accompanied the product launch also benefited from Web technology. Silicon Graphics organized

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seminars around the world so customers could attend in-person presentations on the new products. Instead of sending representatives from Mountain View to help organize each of the local events, the company supplied information, via the Web, that would enable the regional offices to organize their own presentations to groups ranging in size from 500 to 1,000 people. Sites located in time zones that allowed them to view Webcast Live were hooked into that presentation as well.

By using the Web to help organize the international customer events, the company saved approximately $500,000.

"By putting this presentation information on the intranet, we were able to focus our energies and save time," says Bill Rusitzky, manager of field marketing at Silicon Graphics. "It allowed us to spend more time preparing information for the individual customers, so we could better gear individual presentations to the customers' specialized needs."

Enhancing the company's culture, driving innovation, and providing customers with a wealth of useful and easily accessible new product information were key benefits of the Web-based launch, company representatives say. The financial savings was a major benefit, too. But, Look adds, the whole experience was greater than the sum of its parts.

"I think that by going through the process, we enhanced the culture a little bit more," he says. "Silicon Graphics prides itself on thinking outside of the box. But we were geared up to do things the traditional way again, flying people all over the world. It took Ed McCracken to say, 'Stop. There's a better way to do this.'"

"At first, even in our culture, there was some resistance to the idea," says Look. "But we were thinking 'in the box.' Once we started thinking in this new direction, people starting seeing all kinds of interesting possibilities.

"The Webcast created more unity in the company, because people started putting our technology to new uses, and there was a tremendous sharing of ideas," continues Look. "I don't think there's any doubt that we're a better company for having gone through this experience. People have already developed some very innovative ideas for using our new products for future Webcasts and how we can significantly enhance the Web content that we'll provide." ★

Steve Geissen (geissen@phoenix.net) is a freelance writer specializing in technology. His articles on the World Wide Web and computer technology have appeared in various national and international publications.

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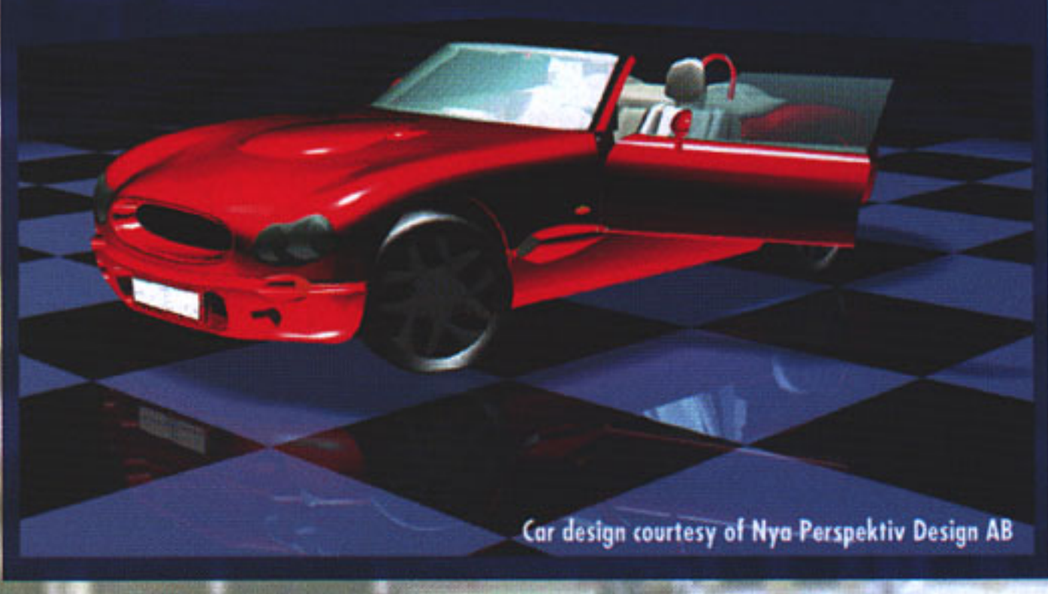

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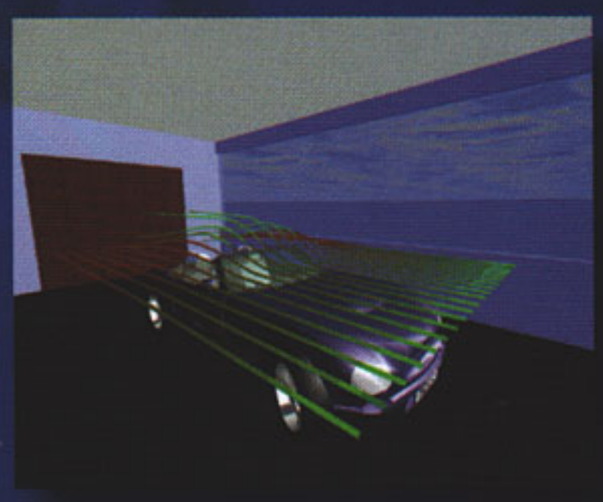

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Electronic Commerce: What's Real—Right Now

by Steve Glaser and Elizabeth Lewis

The Internet was not designed for commerce. It was built primarily for the free exchange of research information, which is not always compatible with business needs. Yet the moment the Net became a public medium, electronic commerce was inevitable, and the blossoming of the World Wide Web hurried the process. We hear hype of a brave new world where we can do everything from the comfort of our own keyboards, but what's really happening in electronic commerce today?

The Web does have some definite advantages for electronic commerce. For die-hard consumers, it combines the best features of mail-order catalogs and TV home shopping networks—no crowds, no parking problems, no hit-or-miss inventory, no bored clerks. Even for those of us who don't belong to the shop-til-you-drop set, there's the convenience of 24-hour access without the hassle of waiting on hold, spelling your name, or having to repeat your zip code three times. Plus, there's the do-it-yourself satisfaction of tapping directly into your supplier's computer to place orders, sell stocks, make reservations, or transfer funds.

This is not to say that electronic commerce has been perfected. There are still major hurdles to overcome before most of us routinely conduct business from our keyboards. But while electronic commerce is still at the frontier of our daily experience, it's no longer the frontier of the early settlers, whose sparse population was served by the occasional trading post. It's now a booming railroad town with a burgeoning population and rapidly expanding enterprise. And everyone in town has a modem.

Virtual Retail-ity

One of the earliest and most celebrated forms of enterprise to appear on line was precisely the one you'd expect—on-line shopping. The first significant commerce site on the Web was Virtual Vineyards (www.virtualvin.com), powered by Silicon Graphics, still going strong as a purveyor of fine wines and foods, as well as a trusted adviser on wines and dining. Today, Web-based dealers such as CD World (http://www.cdworld.com), which boasts more than 170,000 music CDs at discount prices, and Amazon.com books (http://www.amazon.com), home to more than a million discounted book titles, have become major players in their industries, both on line and off.

A Web storefront is a natural for such discount dealers because they can easily handle large volumes of merchandise without the overhead of a physical store. But the relative inexpensiveness of establishing and maintaining a Web presence also makes the Net a comfortable place for small specialty merchants such as map stores (A Galaxy of Maps, http://www.mja.net/galaxymaps/) and chocolate chip cookie vendors (Cookie Bouquets, http://www.cookiebouquets.com/) to set up shop. Some Web stores cluster in virtual malls, sites that include a variety of merchants and services. As in a real-life mall, it's not uncommon to find name purveyors such as Sears, Eddie Bauer, The Sharper Image, and Tower Records alongside unique food outlets, balloon-ride companies, and sunglass emporia. Some representative Web malls are eShop (http://www.eshop.com), BranchMall (http://branch.com:1080), iMall (http://www.imall.com) and

Evergreen CyberMart (http://cybermart.com).

Going Once, Going Twice...

While much Web-based shopping resembles a high-tech version of catalog shopping, the Web's dynamic, interactive nature has enabled innovations such as on-line auctions. A recent search turned up nearly 450 Web-based auctions of everything from airline tickets and professional services to electronics, antiques, collectibles, and fine art. Shoppers can log onto an auction site, look over descriptions or photographs of items for sale, check the high bids, register, and make bids. Obviously, on-line auctions don't run at the same brisk clip as their real-world equivalents. An item may be up for bid for hours, even days, depending on the attention it draws, the time allotted, and the bidding procedure for that particular site.

The ground rules for Web-based auctions vary, but potential participants are warned: This is serious business, not a game. When you bid, you're entering into a legal contract. If you win, you're expected to pay up—in cash, or the equivalent—and promptly.

One of the liveliest and most fully realized auction sites is Onsale (http://www.onsale.com), which specializes in computer equipment. Onsale is in the process of expanding its offerings to include consumer electronics, home appliances, tools, and sporting goods, with the expectation of raising its $35 million in annual sales to the $1 billion level.

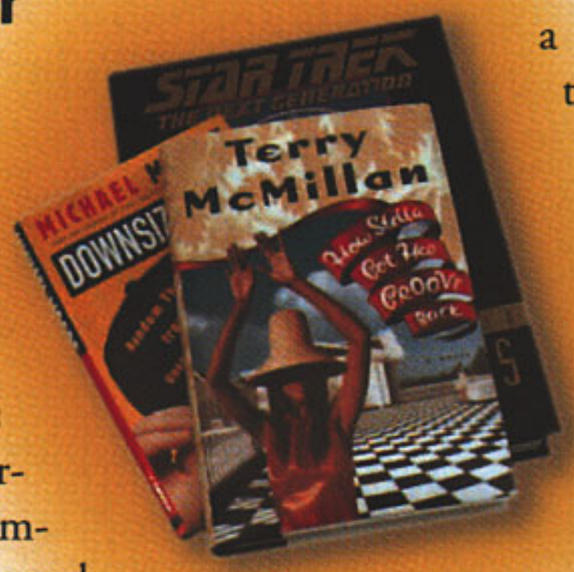
Banking in Your PJs

Electronic banking is not new, but until recently it required dedicated software furnished by your bank, or a commercial software package such as Quicken. Now Web interfaces are turning home computers into virtual tellers. Instead of calling the bank's customer service department, customers can directly access account information 24 hours a day. Electronically connected bank customers can move funds from one account to another, pay bills with automatic fund transfers, and order travelers checks, cashier's checks, or foreign currency. They can look over their transaction history, review credit card charges and balances, and get an up-to-date copy of their statement. They can even apply for a loan or an additional credit card to handle all that shopping they've done at the on-line malls. Many banks, both local and national, are already promoting Web access to their customers. The Wells Fargo Web site (http://wellsfargo.com) offers an enlightening demo.

Put Your Money Where Your Mouse Is

The classic image of the savvy stock investor on the phone telling his broker to buy or sell umpteen thousand shares of Amalgamated Acme is being replaced by one of you, or someone like you, tapping orders into the computer. You can make trades as if you were sitting in your broker's office. But now you can order the transactions any time of the day or night, often by just filling out a form on a Web page.

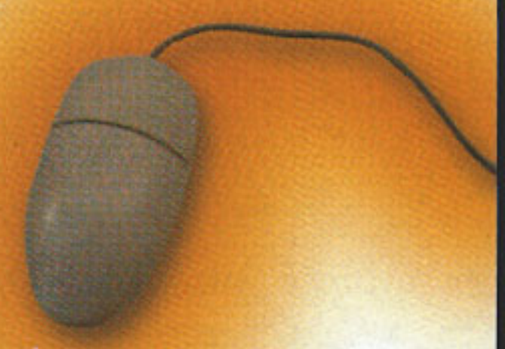
Like electronic banking, on-line investing has been around for a while, but generally through dedicated software or subscription-based proprietary services. Not long ago, discount brokers began to appear on major on-line services such as CompuServe, Prodigy, and America Online. But today, the real action is on the Web. Charles Schwab (http://www.schwab.com/) and Quick & Reilly (http://www.quick-reilly.com/) offer full brokerage services at their Web sites, which also provide investment news and information, including real-time quotes for account holders. Deep discount trading, for those who need nothing more than a broker to process their trades for a flat fee, is available from a number of suppliers, including Schwab's deep discount electronic-trading service, e.schwab.



Tripping Out

Like banking, the travel industry has long been heavily computer-dependent. Web access allows travelers to scout for the best deals and make their own reservations without calling dozens of airlines and hotels. Web-based travel planning is currently a $400-million-a-year business, and many industry experts predict that number to rise to $4 billion within the next few years.

Given those numbers, it's not surprising that one of the busiest commerce sites on the Web right now is Travelocity (http://www.travelocity.com/), a Silicon Graphics WebFORCE server powered site that runs Sabre, the powerful software used by travel agents to find the best travel rates and times. With Sabre tamed for Web use, flight information and reservations, car rentals, and reservations at nearly 32,000 hotels and motels can be handled with point-and-click ease.



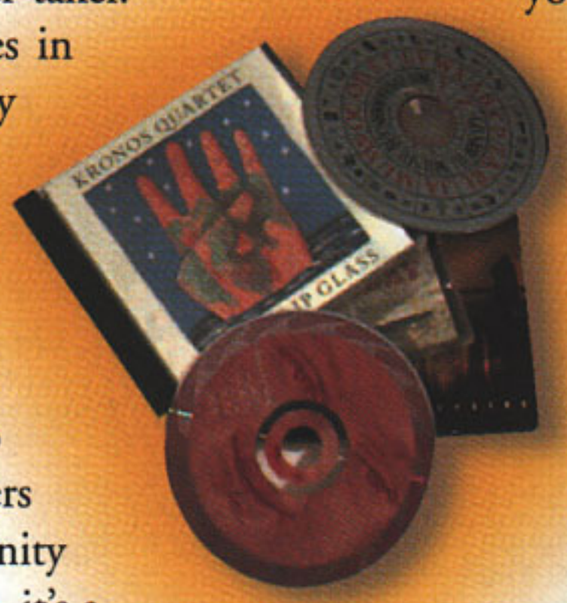
But Is It Safe?

With all these opportunities to spend and save money on line, what is holding up the electronic commerce explosion? In order for the full range of e-commerce options to be practical and appealing to consumers, they must be able to conduct financial transactions without fear that their funds or sensitive account information will be intercepted.

In practice, there have been very few incidents of financial fraud on the Web.

Supplying your credit card information on line is at least as secure as handing it to a department store clerk or reciting it on the phone to a catalog order-taker.

Yes, there are holes in Internet security. As any transaction winds its way from your PC to the merchant on the other end, there are ample opportunities for credit card numbers to be intercepted and orders forged. As the opportunity for on-line fraud grows, it's a sure bet that predators will increase. But there are already a number of encryption systems in place capable of providing reasonable security for on-line transactions. Assuming your Web browser includes built-in security protocols—most of the major ones do—e-commerce is as safe as any financial transaction you might make off line.



Visa and MasterCard are testing a system called SET (Secure Electronic Transaction), designed to be the standard for securing all electronic credit card transactions. Other encryption systems allow "digital signatures," verifications that an order or piece of e-mail actually came from its professed source and arrived without tampering.

Another approach to the challenge of securing on-line financial transactions is electronic cash, or e-cash, which some predict will replace checks, debit cards, and even paper money. Three primary e-cash systems are currently in operation. Digicash (http://www.digicash.com/), licensed to the Mark Twain Bank in the U.S., requires users to open a checking account with that bank. Funds can be drawn from a credit card or a traditional cash deposit. The bank then issues electronic "coins" that are used to purchase goods or services from participating merchants. Merchants submit evidence of the transaction and are paid using funds from the buyer's account.

Rather than holding money in reserve, both Cybercash (http://www.cybercash.com/) and First Virtual (http://www.firstvirtualmall.com/) serve as middlemen between the merchant and the customer's credit card. When a buyer

It Takes More Than an "Electronic Brochure"

by Steve Glaser

What does it take to make a successful Web commerce site? Silicon Graphics' research and experience shows one thing beyond a doubt: good product information and an e-mail address won't cut it anymore—if it ever did.

Silicon Graphics has identified the six items vital to long-term Web-based commercial success:

Compelling content—to attract customers to a site and grab their attention once they arrive.

High-performance, scalable servers—to give users the quick response they demand. And since the transaction rate of a successful Web site can grow exponentially, the server must also be able to grow at an exploding rate to keep the site's very success from killing it.

Professional Web authoring tools—to develop HTML, Java, and VRML 2.0 content for the Web, products such as the Cosmo toolsuite provide a seamlessly integrated Web authoring environment.

Secure transaction processing—to give customers the confidence they need to make purchases in a safe environment, as well as to protect the merchant's security.

Personalized site marketing—to customize presentations to individual customers and target their tastes and demands.

Systems integration services—to ensure that all components of a large-scale project work together seamlessly.

Bringing all that functionality to a Web site has always been a challenge. So Silicon Graphics selected leading companies in all of these areas to join forces and streamline the process. This joint effort has resulted in two new solutions to simplify Web-based storefront development: the WebFORCE Commerce Toolkit and the WebFORCE Commerce Jumpstart CD.

The WebFORCE Commerce Toolkit puts the finest Web site development tools into a single package, enabling developers to custom craft and fine-tune their sites more efficiently than ever before. "Until today, creating Web-based electronic storefronts was an expensive, time-consuming process, requiring a great deal of customer development work," says Kai-Fu Lee, vice president and general manager, Web products division of Silicon Graphics. "The WebFORCE Commerce Toolkit is the first open, fully integrated set of products for creating and managing the industry's most demanding electronic commerce sites."

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makes a purchase, the merchant notifies the e-cash company, which gets authorization from the customer, then charges the customer's credit card account. The credit card company pays the e-cash firm, which in turn pays the merchant. It may sound complex, but it works quite smoothly in practice.

E-cash is primarily a way of adding a layer of security to what is, in effect, a simple credit card purchase. The buyer's credit card information never travels across the Internet; it remains secure with the e-cash company. In the near future, funds may be drawn directly from a user's bank account, which will also help eliminate problems.

One major initiative to help establish trust and confidence in electronic transactions is eTrust, a joint venture between the Electronic Frontier Foundation and CommerceNet (http://www.etrust.org). Their mission is "to promote the mass adoption of electronic commerce by creating an infrastructure to establish and evolve guidelines on issues such as privacy, security, and authentication." Their first project will develop and license recognizable and credible symbols, "trustmarks" of privacy and security, to on-line merchants who meet the standards spelled out at their site.

It's only a matter of time before security standards evolve to the point where consumers feel safe entrusting their orders to the Internet. When that happens, Web-based commerce, already growing rapidly, will boom. Some are predicting that an end to security fears will mean in excess of $600 billion worth of business annually conducted on the Web by the decade's end. With that much at stake, you can look forward to many more intriguing ways to spend your money as businesses take advantage of the latest technological developments to offer new kinds of products and services on line. It may make temptation harder to resist, but it sure beats circling mall parking lots or waiting long minutes on hold. ★

Steve Glaser is the owner of Steve A. Glaser Communications Services, which provides consulting and writing services for business, education, and non-profit organizations. Elizabeth Lewis is a freelance writer who writes about the Internet and cyberculture. They live in Champaign, Illinois.

The WebFORCE Commerce Toolkit consists of software from the following companies:

CADIS, developers of Krakatoa Catalog Publishing technology. Krakatoa Web Catalog Publisher enables organizations to create interactive Web catalogs for electronic commerce using CADIS' interactive "finding" technology. This allows end-users to rapidly and intuitively find products or data of interest in an on-line catalog.

EveryWare, Inc., developers of Tango. EveryWare Tango simplifies database connectivity, giving Web administrators the ability to rapidly create Web applications with point-and-click ease, without having to write any SQL or HTML code.

Open Market, creators of leading back-office infrastructures. Many merchants save time and expense by economically farming out the technical details of handling business transactions, allowing their in-house staff to concentrate on content and customer relationships.

V-ONE Corporation, network security leader. V-ONE's products create full security for Internet merchants, from a customer's computer to the merchant's system and back again.

For those who want something easier still, the WebFORCE Commerce Jumpstart CD contains three turnkey Web storefront applications complete with catalog creation capability and shopping cart software, ideal for small to medium-sized merchants. Lee says, "As electronic commerce comes of age and more commerce-enabled products are introduced into the marketplace, it has been difficult for merchants to discern which applications will best suit their needs. We are now offering these electronic commerce applications on the WebFORCE Commerce Jumpstart CD to provide our customers with quick, easy and cost-effective electronic commerce storefront solutions that utilize the unmatched performance and scalability of our WebFORCE servers."

The software integrated into the Jumpstart CD comes from the top companies in Web site development:

iCat, interactive catalog innovator. The iCat Electronic Commerce Suite makes it easy to put complete interactive catalogs on the Web, thanks to more than 250 customizable templates that automatically format any information the merchant desires.

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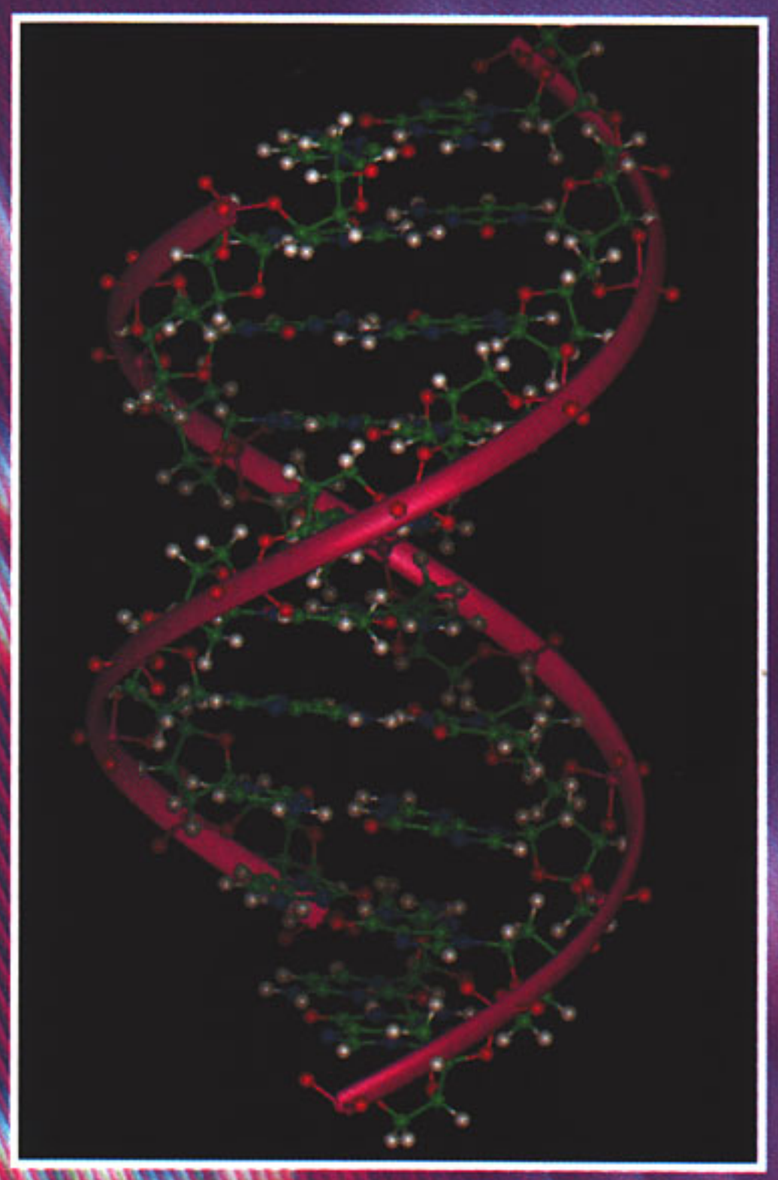

The Gene Counters

by Cynthia M. Marshall

Can scientists cross-breed high-speed databases, intranet communications, and molecular biology to meet the medical challenges of the 21st century?

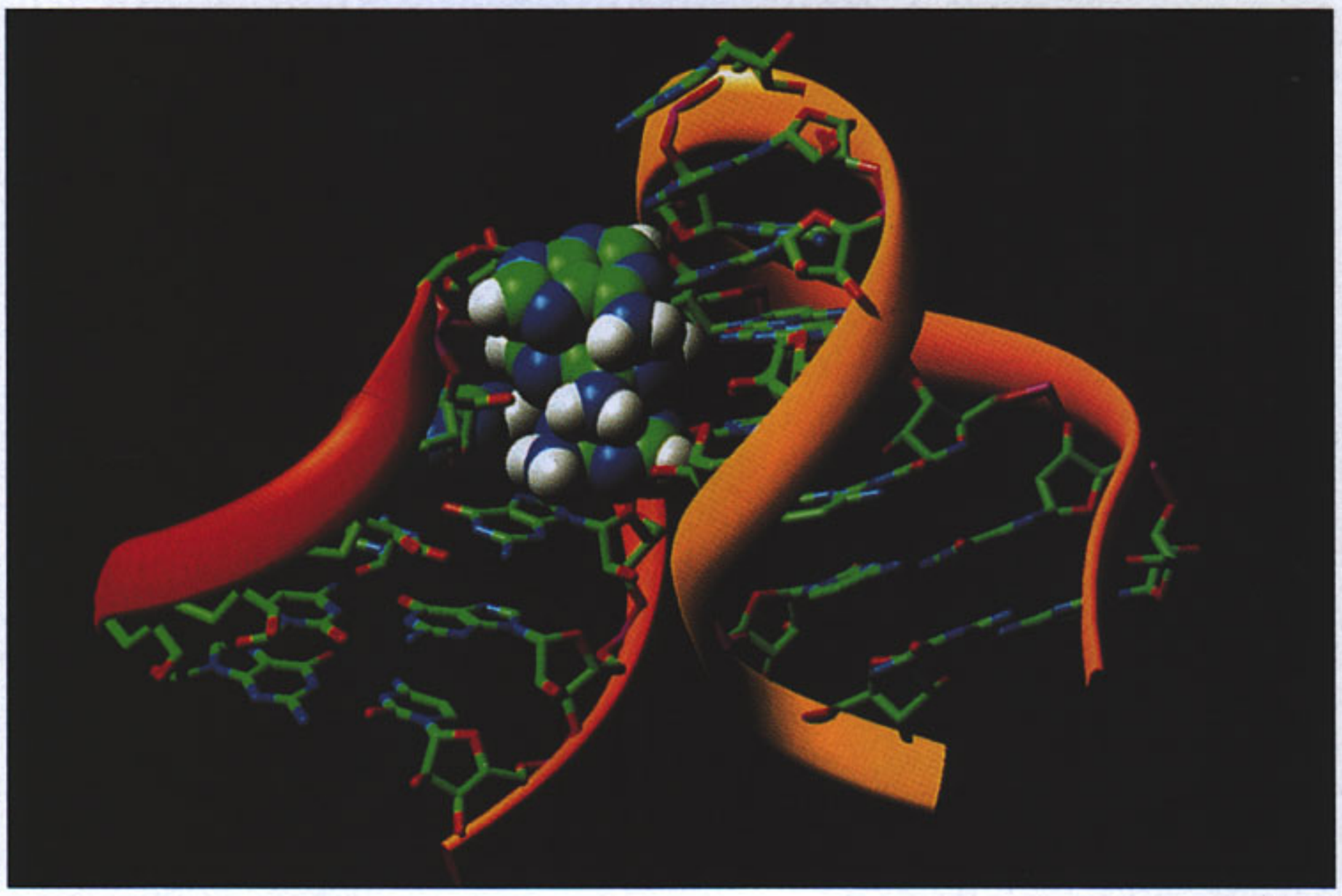

Image courtesy of Molecular Simulations, Inc.

Recently, a group of leading scientists from the Battelle Institute—the same place that has brought you everything from bar codes to uranium processing to xerography—met to speculate on which ten technologies would be most influential during the coming decade.

Their top choice? The mapping of the human genome. It's easy to understand how this could be the top vote-getter; already, hardly a day goes by without genes somehow making news. Homicidal behavior, obesity, intelligence, sexual orientation—you name it, and science has found (or is working on) a genetic explanation for it.

Despite the extent to which media hype may have trivialized the topic, the mapping and sequencing of human, and other, genomes has tremendous potential for the treatment and understanding of disease—assuming that the accompanying mountains of raw data can be adequately managed and massaged.

Why Genomics?

The human genome is a *pièce de résistance* among molecular biologists because it defines, biologically speaking, the sum of characteristics that makes each of us unique in all the world.

The genome consists of individual units known as genes. Specific genes "code for" specific characteristics, such as the shape of your ears or the amount of insulin produced by your pancreas. A characteristic is "expressed" by the production of proteins that directly or indirectly build the nose, manufacture hormones, and so on.

Understanding how a particular organism's genome is mapped—that is, where each gene is typically found on a strand of DNA—provides biologists with, among other things, a road map for locating the molecular pathways by which disease occurs.

Perhaps even more interesting to biologists is each gene's sequence, the string of chemical instructions (each one called a base pair) that codes for the production of protein precursors. "[Gene sequencing is used] when you're doing any number of things," explains Joel Bellenson, C.E.O. and chief scientist at Pangea Systems, a bioinformatics systems integration firm based in Alameda, California.

"One is when you're looking at the same gene but across many different people. You might see that the gene is the same in some areas and different in others. Those areas that are different can be seen as important in terms of determining the nature of disease. Another example is looking at the history of life, evolution, and seeing what a similarly functioning protein looks like over different species," he remarks.

While the process might sound straightforward enough, the sheer volume of data involved is enough to make even the most intrepid database administrator's blood run cold. The human genome, which itself contains some 100,000 genes, has associated with it upwards of 3.5 billion base pairs. Logical extensions of the project, to map and sequence, say, the genomes of people of different races and from different geographical areas, as well as at different stages in the life cycle and disease progression, cause the numbers to go from large to potentially colossal in size.

Can scientists cross-breed high-speed data-bases, intranet communications, and molecular biology to meet the medical challenges of the 21st century?

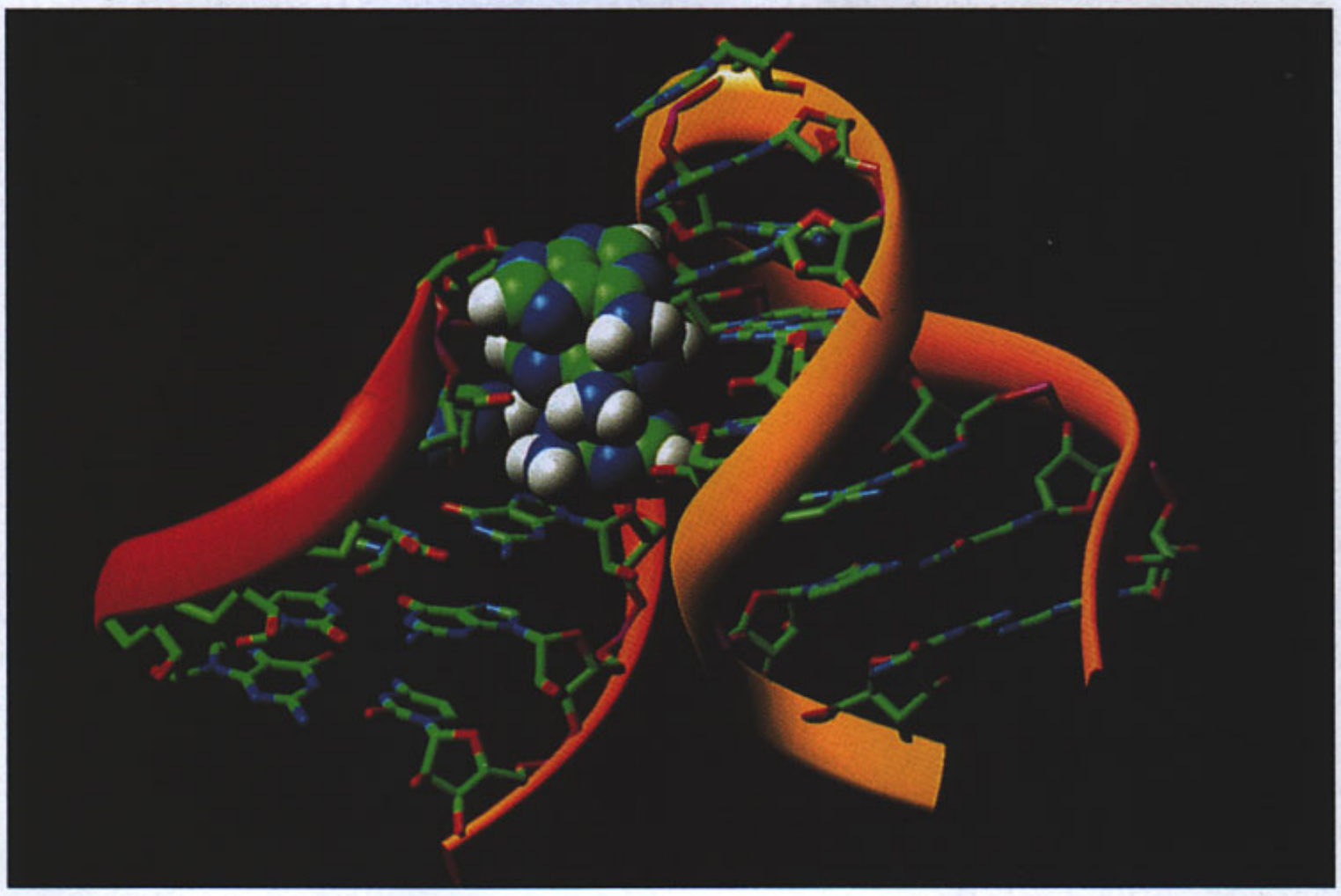

Image courtesy of Molecular Simulations, Inc.

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Much of the activity in bioinformatics is not "How do we use computing to solve a problem stated in biology?" But "How do we use information systems—computers, software, software engineering methodology, et cetera—to enable biology?"

"As discussions started about the genome project, in the '85–'86 time frame," recalls Chris Fields, chief scientific officer at Molecular Informatics, another bioinformatics systems integration firm in Santa Fe, New Mexico, "people realized that if the genome was going to be sequenced, it would produce what they then regarded as a huge amount of data. Some of the early reports written by the D.O.E.'s advisory committee—the National Academy of Sciences, the Office of Technology Assessment—all emphasized that new efforts would be required both in algorithm development and in databases to support the genome project."

And so the field of bioinformatics as we currently know it was born.

Bio-*WHAT?*

Not so long ago, if you thought of bioinformatics at all, you were likely to think of working with simple tools and small data sets. Anything large or ambitious was pretty much out of the question.

"The tools were rather primitive when I started using them for sequence analysis in the mid '80s," Bellenson remarks. "What they were able to do was very, very limited, and people were happy with very small things. Just being able to line up two sequences was a big feat."

"Many problems simply weren't solvable," Fields concurs, "which are now solvable just because of a change in the kind of technology that's available."

Perhaps surprisingly, the technology to which Fields refers is remarkably similar to what you'd find in most competitive business environments: databases, networks, graphics, and the like.

"Much of the activity in bioinformatics is not 'How do we use computing to solve a problem stated in biology?'" Fields elucidates. "But 'How do we use information systems—computers, software, software engineering methodology, et cetera—to enable biology?'"

A central part of enabling biology involves establishing an enterprise-wide communications infrastructure, or intranet, so that colleagues within the same company can exchange information and access the same databases. "Many of our customers are companies that have sites in the U.S., at one or more locations in Europe, in Japan, and perhaps elsewhere," Fields observes. "They may be using several servers, all of which need to communicate with each other. Within a site, tens to hundreds of individuals, usually researchers, will have desktop clients talking to the server."

There is no shortage of genomic data available in the public domain, accessible via the Internet. GenBank, a public database maintained by the National Center for Biotechnology Information (NCBI) contains information about a million DNA sequences collected from over 16,000 species. GenBank searches are conducted using query tools with names like BLAST. Each day the NCBI receives roughly 40,000 requests to search GenBank—most of them from researchers on the Internet.

In addition the Human Genome Project, the National Library of Medicine, and a number of related institutions recently made a partial map of the human genome available on the Internet.

A High-Stakes Commercial Venture

The Internet is well-suited for some sorts of bioinformatics projects, but for many commercial research undertakings, such as new drug development, concerns about Internet security make it preferable to bring the databases in-house.

"We don't use the Internet servers because of potential public disclosure complications. If we were to send one of our sequences out, that might represent a public disclosure, so we don't do that. We run all of our BLAST searches and sequence analyses in-house," says Scott Presnell, a bioinformaticist at Seattle, Washington-based Zymogenetics. Zymogenetics' business strategy is to increase the number of promising potential new drugs and to cut their research and development time by using genomic data.

A number of companies have sprung up in response to strategies like Zymogenetics'. For example, Pangea Systems and Molecular Informatics develop and configure customized intranet and database technology to work with a company's own data. Other firms, specializing in an area known to insiders as functional genomics, map and sequence the genomes of organisms in their own collections. The resulting databases are then sold, primarily to pharmaceutical companies. Palo Alto, California-based Incyte Pharmaceuticals and Woburn, Massachusetts-based AlphaGene are two such functional genomic firms.

"[A potential client] can come to us and be up live and running within a month's time," notes Randy Scott, exec-

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Classically, Silicon Graphics has had a strong penetration in the molecular modeling and 3D visualization of molecular structures. Almost every pharmaceutical company with hard-core bioinformaticists and structural biologists is using Silicon Graphics platforms.

utive vice president and chief scientific officer of Incyte Pharmaceuticals.

"Then," he says, "it will generally require a couple of dedicated support people on their end and a fair amount of hardware."

The *de facto* standard for hardware to integrate bioinformatics into pharmaceutical R&D computing environments is Silicon Graphics.

"Classically, Silicon Graphics has had a strong penetration in the molecular modeling and 3D visualization of molecular structures," Scott explains. "Almost every pharmaceutical company with hard-core bioinformaticists and structural biologists is using Silicon Graphics platforms. Silicon Graphics has been the standard in any kind of three-dimensional structure and modeling programs for chemists and molecular biologists."

"Silicon Graphics is serious about taking a position in bioinformatics. I think they view it as a very fast-growing industry, where there's a great need for metal," concurs R. Mark Adams, director of bioinformatics at AlphaGene.

The Payoff—Better, Faster, Cheaper Treatments

Estimates from the Office of Technology Assessment indicate that the cost to bring a new drug to market exceeds $359 million. The time involved can be as long as 20 years. While bioinformatics provides no guarantee of overnight miracle cures, this new discipline will surely streamline what historically has been an expensive, hit-or-miss process.

"It's analogous to the computer industry," Fields comments. "Before the development of electronic computers, people used mechanical calculators, and prior to that they used paper and pens. They were doing many of the same things, but they couldn't do it on anything like the scale or with the throughput required to make a significant impact.

"For example, how do you isolate the factors in a microbial pathogen that make it infective? Most pathogens have very, very close relatives that aren't pathogens; they just go about their business in the natural world, but they don't make you sick. Asking that question involved doing extremely laborious molecular biology, and could take a very long time. You never knew whether you had the right answer, or a complete answer, or any of that.

"Now," Fields continues, "any company that can build or contract out a moderate-scale DNA sequencing facility can completely sequence the genomes of both the pathogen and the nonpathogen in just three or four months. Then they've got the entire thing; they can go through and list all the differences and test them systematically, and they know when they're done. It can be done very cheaply and efficiently compared to traditional methods."

What's Next?

According to the NCBI, the amount of genomic data available doubles every 14 months. As such, the immediate future for bioinformatics will most likely consist of further enhancements to the databases and associated query tools.

"This whole thing that Silicon Graphics talks about, data mining, is going to be a very real thing now in biology," Adams comments.

"[Data mining] means to me the implementation and design of algorithms or techniques for extracting data from a big database, often by comparisons of the data to itself, classing of data, and so on. It means asking questions of a big database and getting answers that may surprise the person asking the question," he concludes.

A little further down the road, don't be surprised to see applications of bioinformatics at hospital bedsides and in doctors' offices.

"Bioinformatics will play a very central role in the evolution towards more individualized therapy," speculates Fields. "One day, a doctor may very well be able to say, 'We're going to test your genomic background and perhaps your current state of gene expression and protein activity.' Then, given these test results, he or she may say, 'What we need in your case is a combination of drug number 12 and drug number 27 out of, say, 40 or 50 drugs.'"

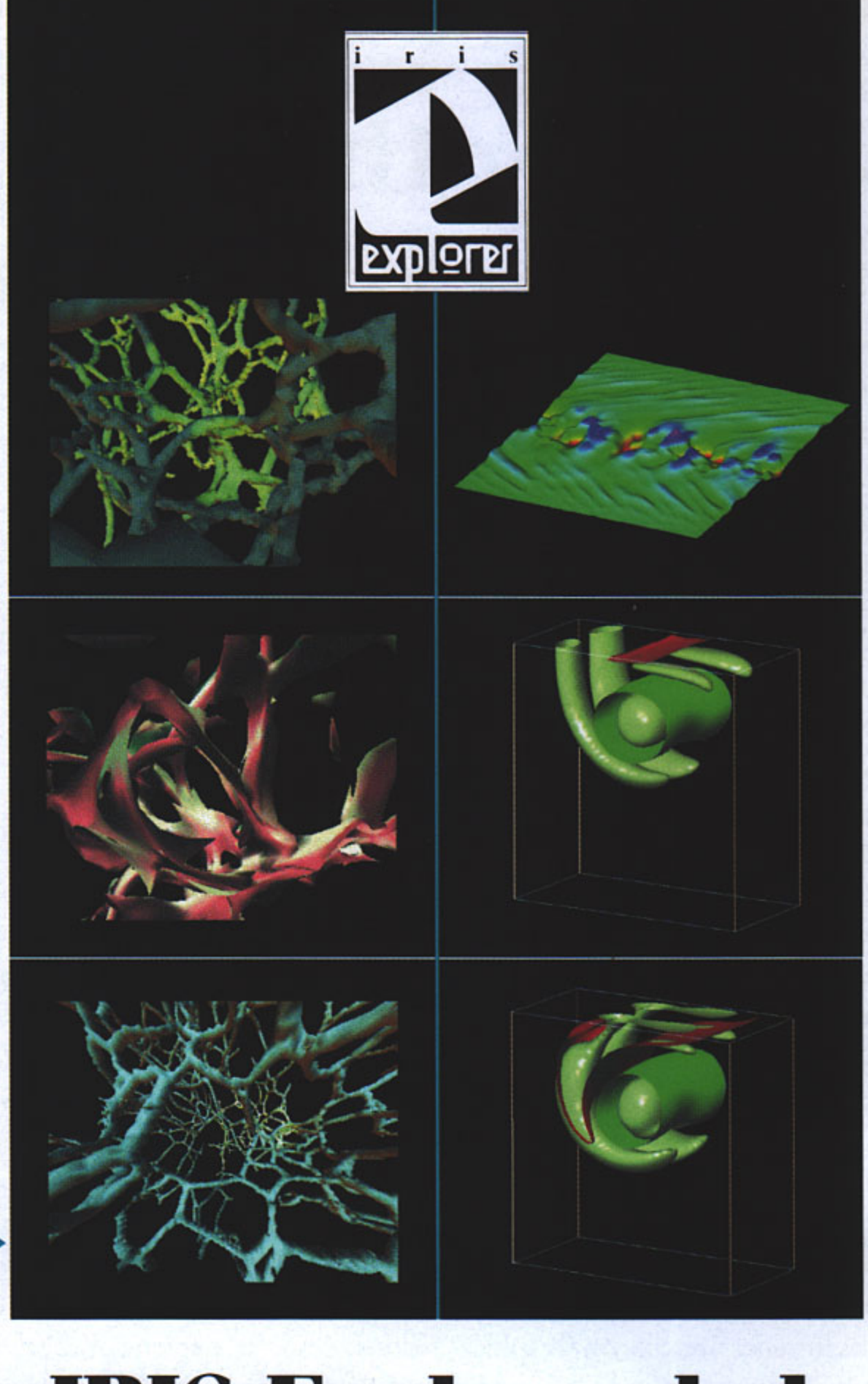
What can be said for sure is that the work will never be completely finished. "The difference between us and most of the hard sciences is that biology is very floppy and ill-defined," Adams philosophizes. "Life keeps it that way—it's a complex, evolving system."

Cynthia M. Marshall is a freelance science and medical writer living in Mountain View, California.

Ue-Li Pen, Ph.D.
Center for Astrophysics*

I am a theoretical cosmologist studying the origin and structure of the universe. IRIS Explorer helps me visualize clusters of galaxies as interactive, 3D datasets. And we're dealing with some big datasets. Using IE routines like Volume Rendering is like having a telescope that can see 350 million light years, or like creating a huge spaceship that can whiz around in deep space and examine our simulation. IE accelerates my work and makes it easy to show to non-experts. I'm currently studying the core sizes of clusters of galaxies in numerical simulations. These were unknown until we ran out simulations with IE. Being able to calculate their size is quite an event.

Cosmic strings and universe contours made visible with IE 3.0 on a DEC 3000 with 256MB RAM.



Leonard Imas
The Dept. of Ocean Engineering, MIT

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Ship wakes and free surface flow with surfactant created on a Silicon Graphics R8000 Power Indigo2 and a DEC Alpha 600/333**.

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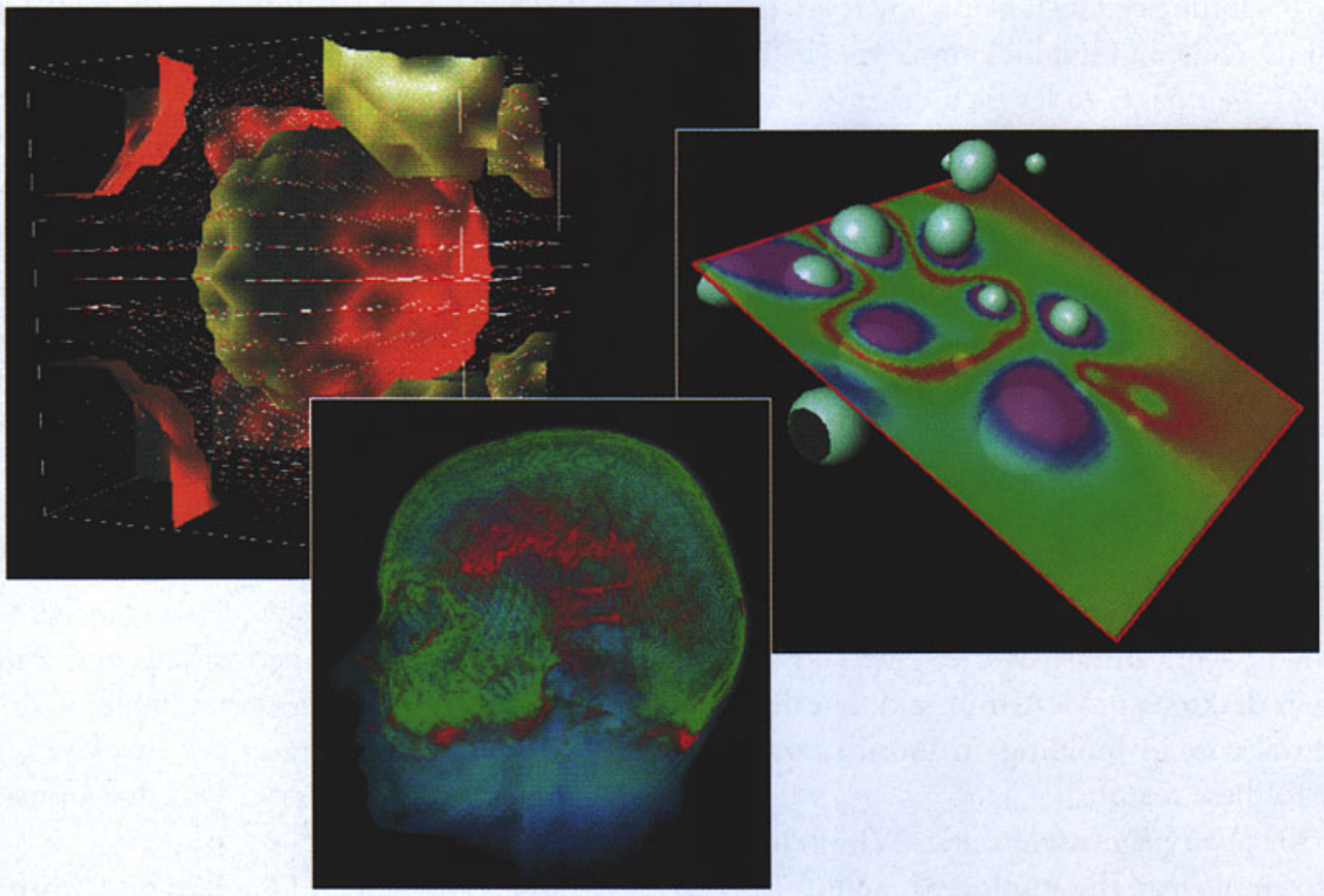

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CIRCLE READER SERVICE CARD NUMBER 16

Measuring the Impact of a Corporate Intranet

Some Hard Data At Last

by Sharon Fisher

One of the unexpected side-effects of the rapid emergence of the Web as a popular development platform was the discovery that it could facilitate communications and data management within organizations just as powerfully and gracefully as it could worldwide. Once exposed to the technology, businesses readily adopted it for internal use. The proprietary versions, known as intranets, quickly became a major new standard for in-house document management, information distribution, collaborative work processing, enterprise-wide communications, and many other applications.

Claremont Technology Group, Inc., a systems integration and technology solutions consulting firm based in Beaverton, Oregon, has quantified the benefits of intranet adoption in a three-part study. Claremont's clients and alliance partners include Arbor Software, AT&T, Bay Networks, Forte Systems, Lotus, Merix Corporation, Microsoft, Netscape, Open Horizon, Oracle, Spry/CompuServe, Sybase, and Silicon Graphics. The companies that participated in the study were AT&T, Pac Bell Internet, and Silicon Graphics. Each phase of the study focused on a single company, selected to demonstrate either the organizational, financial, or technical impact of its intranet use. Silicon Graphics was chosen for the organizational phase because of its highly entrepreneurial spirit and established worldwide intranet.

Background

As early as the beginning of 1995, before the term 'intranet' was in widespread use, Silicon Graphics employees had begun creating individual Web pages to let each other know what individual departments were doing. The process proved so popular that, later that year, the company widely distributed the Netscape Navigator Web browser and Web authoring tools, and developed a gateway, dubbed Silicon Junction, to give employees a standard entry point to the corporate intranet.

According to Jocelyn McArthur, a marketing manager in the Silicon Graphics Web Products Division, the intranet was produced at very little cost. While the company does pay a royalty for browsers such as Netscape Navigator, the authoring tools it distributed to employees were its own, and the network itself was already in place. "One of the points of the study is that we had an existing network infrastructure," she said. "People had systems on their desktops." McArthur said that there was very little incremental cost in building an intranet within Silicon Graphics due to these reasons.

Initially, the Web pages were static. While they provided information to employees, the employees couldn't interact with them. In 1996, though, Silicon Graphics began using its intranet to augment, and in some cases replace, existing systems with intranet applications.

The Claremont survey was conducted during the summer of 1996 and released in September of that year. A total of 850 surveys were returned in only three days, and 900 surveys were received over the one-week period. This represents 13 percent of all employees. Preliminary findings showed that Silicon Graphics' use of intranet technology had significantly increased its effectiveness as a global organization in several different areas: improved productivity, enhanced knowledge capital, strengthened teamwork across boundaries, improved process efficiency and workflow, and increased employee satisfaction.

"The study was one of the first published anywhere that cited actual benefits of an intranet," McArthur said. "Before the study, everybody—ourselves included—was talking in theory about the benefits of an intranet to a company. It made intuitive sense, but this was the first time it was measured."

Overall, 63 percent of employees surveyed said they used the intranet to obtain information required for their jobs, and more than 60 percent said it was essential to their daily job functions. Also, 92 percent of those responding thought the information in the intranet was accurate, 85 percent thought it was timely, and another 85 percent found it easy to use.

Case Studies in Savings

The Silicon Graphics human resources department, for example, uses the intranet to distribute policy and procedure and HR-related information, and to provide training. The latter has resulted in an estimated savings of $30,000 per month. Since the Claremont survey was conducted, McArthur explained, Silicon Graphics has added a new on-line human resources system to its collection of Web applications. "It's a password-protected system that allows employees to go in and bring up any benefits information," such as health benefits or stock options. "Anything that's human resources-related and has to do with 'me'," she said.

The Silicon Graphics intranet also helps get new employees up to speed by offering managers "one-stop shopping." The new employee system lets a manager order office space, services, communication, networking, and computer equipment for new employees. The intranet helped reduce this process from two hours to 15 minutes per employee. This is estimated to save 2,100 staff hours per year, for a projected savings of $73,000 annually.

The Silicon Graphics sales force uses the intranet as well, to receive sales tools and information about the industry and com-

petitors. Previously, sales personnel had to wait weeks to get information through the mail. Moreover, because sales personnel can check on the status of manufacturing and order shipment on their own, calls to the order administration department have been reduced by 50 percent.

In another example, the engineering and manufacturing departments developed a single interface to legacy databases, such as those containing part numbers, sales orders, and engineering change orders. The result? Faster and more efficient access to manufacturing data, reduced software licensing and maintenance costs, improved network performance, and reduced upgrades.

Silicon Graphics is using its intranet for requisitions as well. With no additional resources, the intranet-based electronic requisition system reduced the processing time for requisitions by 18 percent, and reduced the average processing costs by 25 percent. Processing now takes five days, whereas it used to take three weeks.

Employees are also using the intranet to collaborate. In some cases this means electronic mail, but some engineering departments are using the intranet to help manage their projects. The ability to link employees in multiple locations and provide them with more up-to-date access to timely information about the status of a project has resulted in more effective project management and reduced costs. More than 61 percent of Silicon Graphics employees reported that they have used the intranet for collaboration, while another 60 percent said that their workflow had been streamlined through its use.

Toward the Future

At Silicon Graphics, the intranet has progressed from a grassroots effort by individual employees to recognition as a key component for both organizational development and success in the marketplace. Now, the company is working to identify and develop intranet-based mission-critical applications that can actually make Silicon Graphics more successful in an increasingly competitive business and technological environment. Future areas of expansion include the use of three-dimensional computing, video broadcasting (particularly for training and education), forecasting, workflow applications, desktop videoconferencing, and automated telephone and facsimile systems.

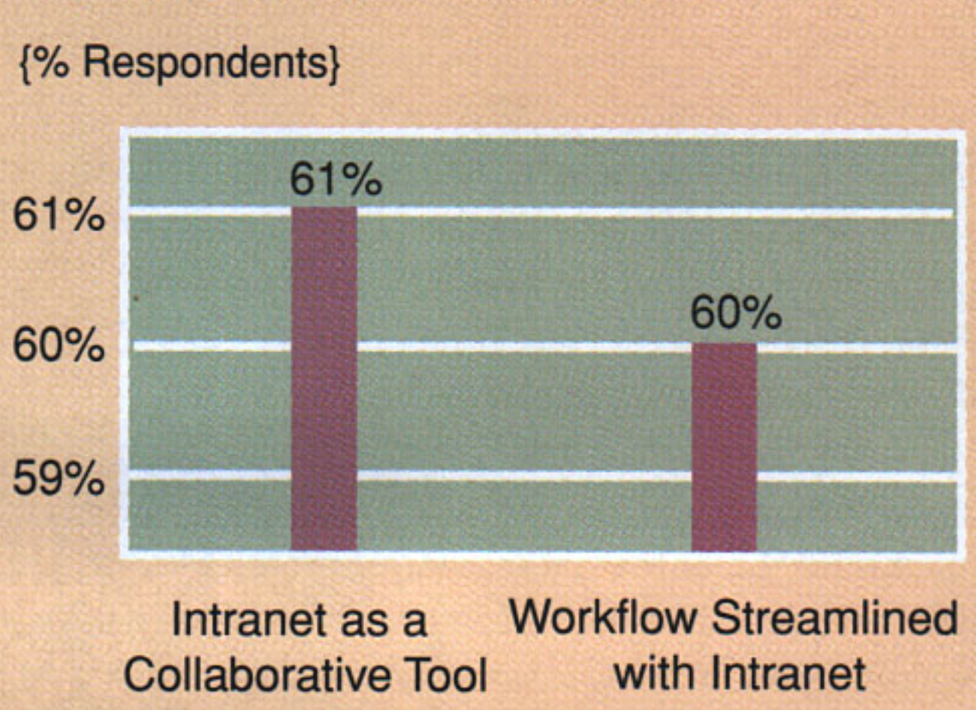
According to Scott Houghton of Claremont Technology, the overall project leader for the intranets benefits study, "The intranet is an excitingly new technology, one which will bring significant changes to the way systems are developed and the way business is conducted. Silicon Graphics has been a leader in this technology and a model for businesses entering into this technology. The intranet benefits study has provided great insight into what has been done with the intranet to date, its future direction within companies, and the significant benefits that have been gained." ★

Sharon Fisher is a senior editor at Communications Week. *She is also the author of* Riding the Internet Highway.

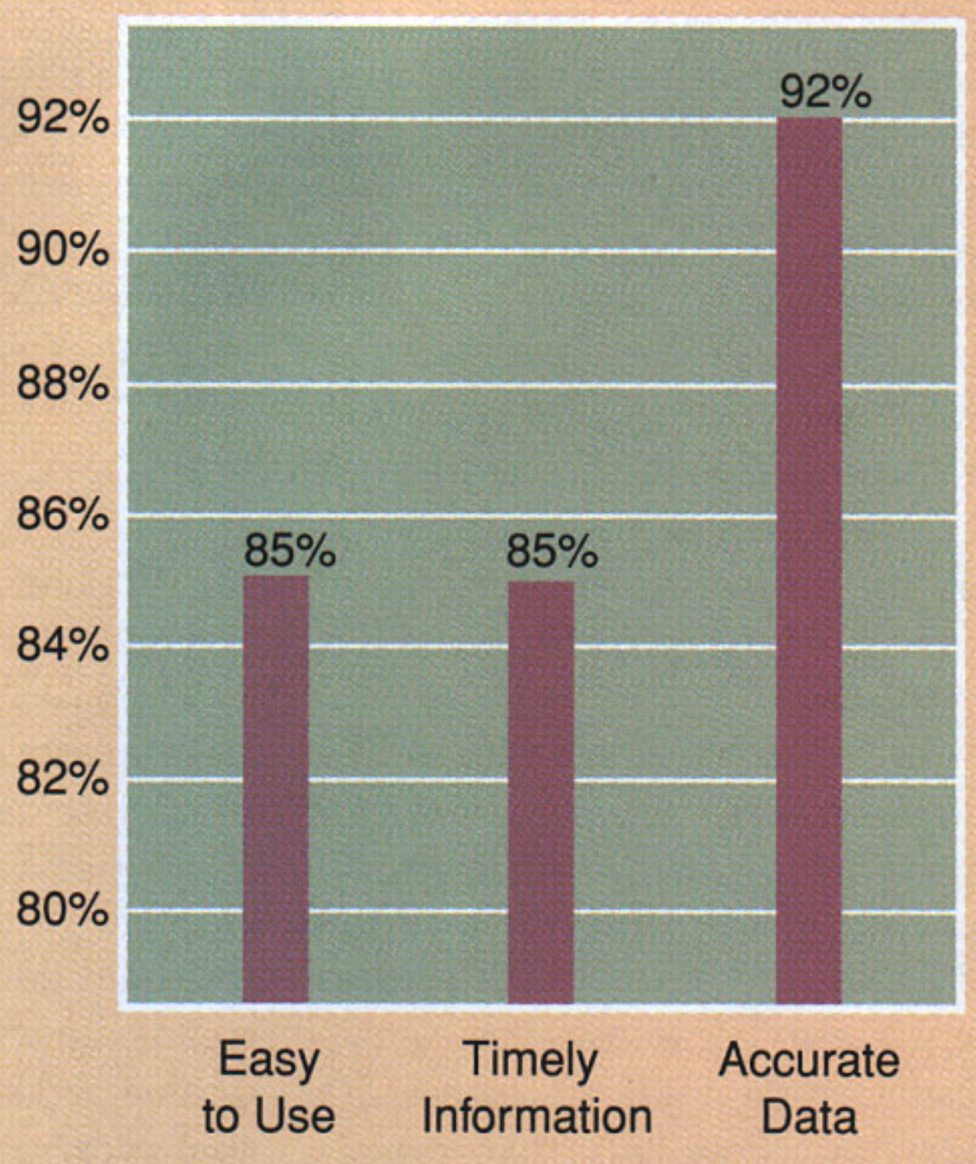
Estimated Savings from New Employee System

Estimated Average Hourly Cost per Employee	$35
Estimated Hours Saved	2,100
Estimated Yearly Savings	$73,000

Collaboration and Workflow



Information Availability and Access



Brave New Worlds

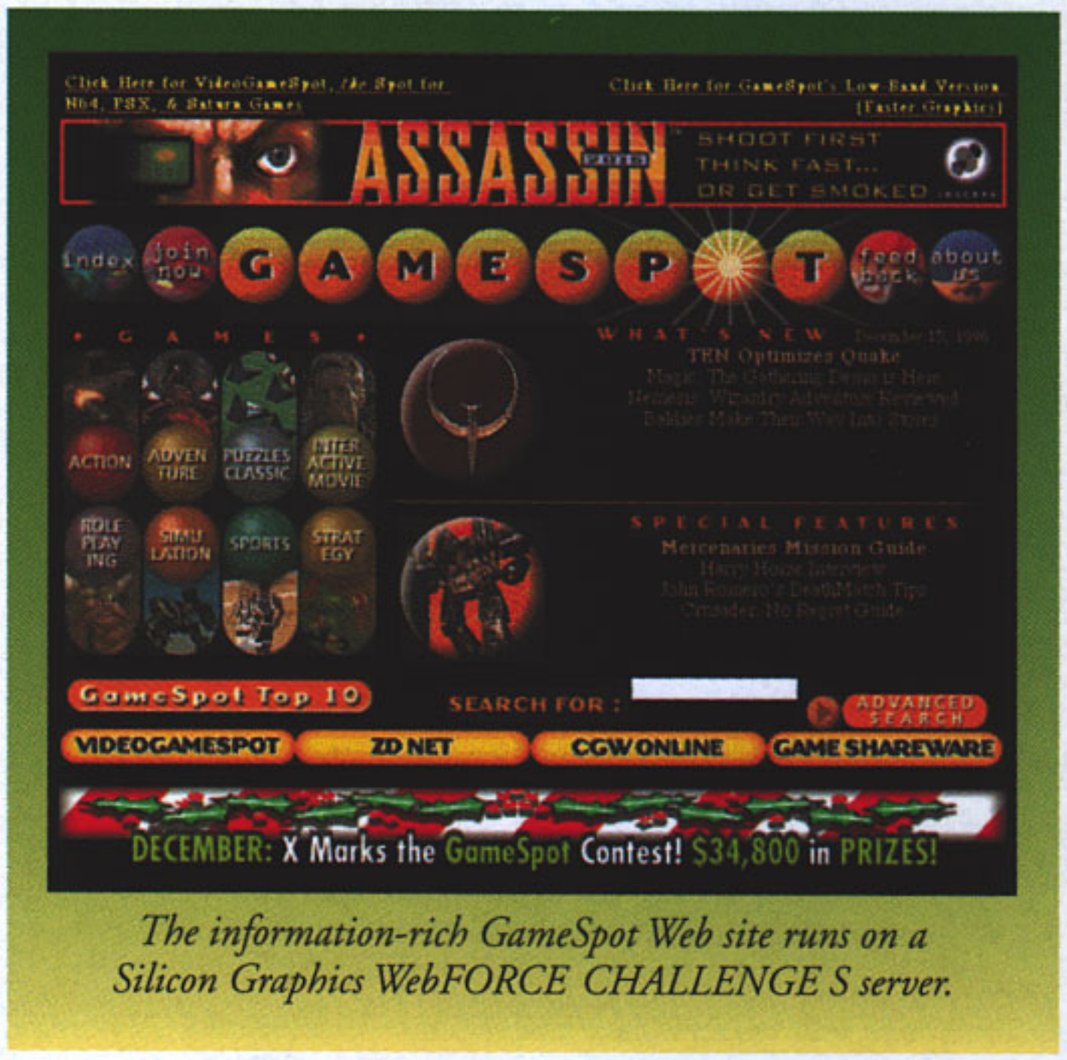
Multiplayer Games Come to the Internet

by Thom Elkjer

It's a bright summer morning in a rural city with a medieval architectural heritage. Few residents are thinking about the past, however. After a gang-related brawl in a local bar, some townspeople are debating ways to curtail violence. Others believe the town should be more concerned about the flood of strangers arriving from all over the world. They are coming to start a new life in a new land full of opportunity. But many come with so little preparation...

...little, that is, except an Internet account and a copy of Ultima Online on their personal computers. The inhabitants of this town are real enough, and so are the challenges they face. It's the place itself that's virtual: "Britannia" was invented years ago for a standalone PC game called Ultima. Now the game's creator, ORIGIN Systems, is taking Britannia to the Internet so its legion of fans worldwide can play together.

ORIGIN is part of a growing rush by game-makers to recreate popular hits for on-line play. You can now hook up one-on-one for a blood-soaked snarl-a-thon in Duke Nukem from 3D Realms Entertainment, or join a small group recreating World War II tank battles with Panzer General from SSI, or don a persona and join hundreds of others in a fantasy role-playing game. Soon you'll be able to visit a virtual Las Vegas for blackjack or roulette.



The information-rich GameSpot Web site runs on a Silicon Graphics WebFORCE CHALLENGE S server.

All games, on line and otherwise, are becoming intensely visual and three-dimensional. "Silicon Graphics has had a major impact on this aspect of gaming," says Jeff Benrey, marketing manager for interactive entertainment at Silicon Graphics. "Three-dimensional modeling and animation, rapid prototyping, and motion capture are fundamental to game creation, and Silicon Graphics and its software partners keep bringing out better tools for all of them." Last November, for example, Alias|Wavefront introduced powerful new tools for game creators in the most recent release of its PowerAnimator package on O2, the latest entry-level workstation from Silicon Graphics, which gives game designers built-in texturing capabilities (see sidebar).

The vivid reality of the images in on-line games is matched only by the vivid language of the "chat." Featured in nearly all on-line games, chat refers to typed player conversations, which appear in a screen window. These are, after all, games, and the social purpose of games goes back to prehistory.

Games Change, People Don't

"On-line play brings gaming back to its roots," observes Chris Lombardi, editorial director at Total Entertainment Network (TEN), a Net-based game service. "Games were always ways of interacting with other people in a social setting, until computers came along and people started playing against machines. Now people are playing with people again, on line."

Starr Long, producer and director of Ultima Online, describes a 1996 alpha test with thousands of players worldwide. "We saw either intense competition or incredible charity and cooperation," he recalls. "Gaming technology has advanced quite

Three Web site screens from the Net-based game service Total Entertainment Network (www.ten.net).

far, but it appears human nature hasn't changed." Or, as Crimson Sands said, "you'll want friends at your side as some of the missions you'll be undertaking will bring you into conflict with the nastiest and most devious of all creatures—human opponents!"

"The importance of chat is sometimes underestimated," says Larry Edelstein, technical director at GameSpot (www.gamespot.com), an indispensable Web site devoted to reviews, news, and information about on-line gaming. "Players have to be able to communicate, or a lot of the excitement evaporates." Consider any Clint Eastwood movie: it's what he says before he dispatches a bad guy that you remember. Part of the appeal of on-line games is that you get to write your own lines.

My Chess Club Makes House Calls

The grandfather of Net-based multiplayer game services is Outland (www.outland.com). It's natural to compare these game-plexes to cable companies. They all offer a line-up of games, and once you subscribe (and buy or download the necessary software for your PC) you can always tune in to the game of your choice. Created in 1994 for Macintosh users, Outland is one of the few game sites to offer such kinder, gentler games as hearts, chess, go, and backgammon. When George Koltanowski, chess grandmaster and long-time columnist for the *San Francisco Chronicle*, discovered Outland, he said "there's now a chess club that makes house calls."

Outland's lead is being followed by more hard-core game services such as TEN (www.ten.net), MPath (www.mpath.com), DWANGO (www.dwango.com), Engage (www.gamesonline.com), and The Park (www.the-park.com). Game services generally offer at least one thought-provoking game in the SimCity 2000 mold, but the gaming market is dominated by young men and the games that testosterone plays.

It's in these action-oriented games, though, that on-line gaming exposes its Achilles heel: latency, or response delays, between network servers and player PCs. "Latency has slowed the migration of games to the Net, because it makes game play slower than with standalone PCs or game machines," Benrey says. "Of course it's an issue for the World Wide Web as well, and a lot of people are working on it." Latency in game play is not simply a matter of bandwidth and modem speed, however. "With intelligent game design," Benrey explains, "it's possible to minimize the amount of information actually traveling back and forth across the Net."

Within a flight simulation game, for example, the visual renderings of the planes, terrain, clouds, and cockpits are stored on the player's PC or CD-ROM. The only data transmitted has to do with changing variables, such as flight position, weapons fire, and player point of view. The industry's rule of thumb is that such action games maintain impact if a player's latency stays below half a second. (To check your own latency, visit ORIGIN Studios at www.owo.com/ping.html.)

Some of the major game services, in order to offer players lower latency, have actually made an end run around the

Three screens from Ultima Online's Brittania, showing its isometric 3D environment (www.owo.com).

Internet. By partnering with private, high-bandwidth networks, they can speed up the action of the jet fighters, battle-axes, and nailguns. As Edelstein says, "The experience becomes purely visceral. With low latency in a game like Quake, you can kill and be killed forty or fifty times in half an hour, without a moment's rest. It's a rush nothing else can match."

Who's Playing at the 'Plex?

But not everyone plays for the joy of senseless slaughter. "Broadly speaking, gamers are attracted to visceral experiences or cognitive ones," says TEN's Lombardi. "Within that polarity, people will tend to favor either reality-based games or fantasy games." Thus, reality-oriented visceral types seek out simulations of real-life jet fighters and road racers. In contrast, fantasy-loving cognitive types go for role-playing games that unfold more slowly and allow players to create alternative personalities from whole cloth.

Fantasy role-playing games (RPGs)—evolved from the early Dungeons and Dragons adventure—may become far more prominent in coming years, as a broader audience comes to the world of on-line gaming. In fact, there are already a number of 3D on-line interactive fantasy realms without a game dimension, such as those provided by Worlds Chat (www.worlds.net). Games set in these worlds are less threatening than shoot-'em-ups, more forgiving of high latency and slow processors, and tend to be populated with "guides" and "guardians" who show new players the ropes. They also allow people to live a rich imaginary life for a few hours or for weeks at a time.

Gwendolyn Arthur (not her real name) of West Virginia was learning to play chess via an Internet chat channel when a friend introduced her to RPGs.

Brave New Rendering

Conversation with game industry insiders frequently turns up the phrase "Silicon Graphics rendering"—shorthand for the fact that Silicon Graphics tools are deeply entrenched in many game design studios.

Thoroughbred solutions for creating lifelike three-dimensional images on a computer screen include Indigo² IMPACT 10000 graphics workstations and Onyx Reality Station graphics supercomputers running the IRIX operating system and software from Silicon Graphics subsidiary Alias|Wavefront, as well as application developers such as Coryphaeus, MultiGen, Newtek, Nichimen, Paradigm, Sense8, Side Effects, and SOFTIMAGE.

"All computer graphics are not created equally," says Peter Ryce, Alias|Wavefront product manager. The latest release of PowerAnimator, the 3D modeling, rendering, and animation package from Alias|Wavefront, offers a range of new tools for game designers. The ability to automatically smooth out the beginnings and ends of animation cycles, for example, makes action sequences less choppy. The ability to add dynamic properties to specific parts of characters allows designers to be more creative with exaggerated motions such as stretching and squashing.

On the systems side, the new O2 workstation from Silicon Graphics brings higher performance and functionality to game designers at a low entry-level price point. Silicon Graphics has also provided the systems behind numerous Web sites devoted to gaming. The information-rich GameSpot Web site, for example, was built and runs on a WebFORCE solution that includes a CHALLENGE S server and an Indy authoring workstation.

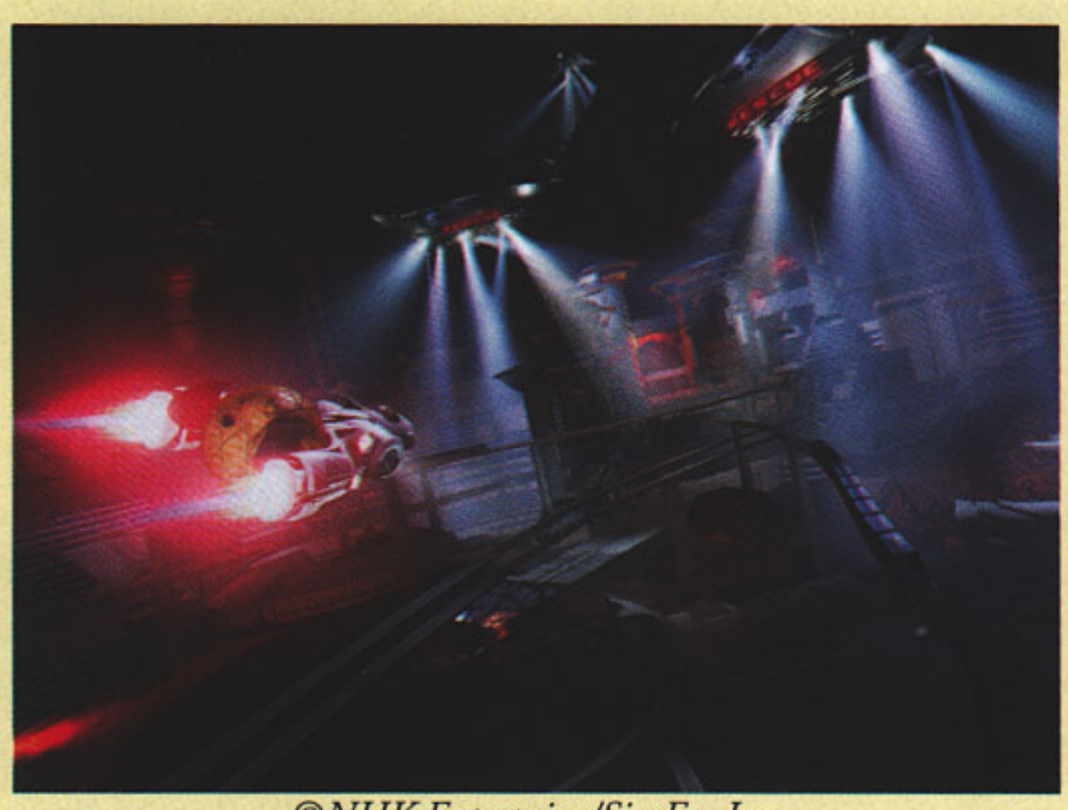


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Image created with Alias|Wavefront PowerAnimator.

Image courtesy of Kronos Digital Entertainment and created with Alias|Wavefront PowerAnimator.

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She created a character named Lady Gwenth and plunged into a fantasy life that she says provided "a welcome avenue of relief from the stress we all face." Within a matter of weeks she was engaged and married in an on-line ceremony complete with rings and vows and a crowd of other characters. "Truly a magical moment," she says.

As it turned out, another character stole the magic by murdering Lady Gwenth and filching her wedding ring. Such player-killing is repugnant to most fantasy gamers, much as homicide is in real life, but it's part of the Dungeons and Dragons experience. Arthur herself is resilient. She's back as a guide now, teaching others how to play.

Awaiting the Ultimate Challenge

While bloody battles rage all over the Internet, many in the gaming industry are looking to Ultima Online to take on-line multiplayer gaming to the next level. For one thing, Britannia is a 3D environment that players experience in an isometric, overhead perspective. This means they can see themselves and what's around them, not just what's directly in front of their eyes. When characters speak, their words appear next to their on-screen persona, not in a group chat window somewhere on the PC screen. This makes it much easier to connect a character's words and deeds. (Live audio communication between players is still in the future, but it's coming.)

More importantly, Ultima Online breaks through one of the psychological boundaries that restricts most games: as in life, there's no winning, and no end. "In the past, computer gamers had to conform themselves to a previously determined experience controlled by a machine," says producer Long. "With Ultima Online, the players form the game and it responds to them. It's a world in every sense of the word."

Jeff Benrey at Silicon Graphics foresees an even further evolution in this direction. "On-line gaming has already blown past the barriers of the shrinkwrapped package," he explains, "because you can get new features, new opponents, and new characters all the time." The next level, he suggests, could be even more intriguing: multiple studios creating new features for existing games, much as plug-in providers create additional functionality for Web browsers. "There's no technical reason we couldn't have many authors for a single game or world," he says. "The market's not there yet, but the Net has a way of creating new opportunities that didn't exist before."

Meanwhile, players worldwide are getting ready to pour into Britannia. Along with commerce, community, and quests, they may well find pitched battles, mayhem, and murder. But thoughtful gamers are looking toward something even more dramatic. "All games present us with the question: Now what do I do?" GameSpot's Edelstein says. "Most on-line games present a fantasy situation, but in the RPGs that are coming out now the choices are getting much more lifelike. The question becomes: Who am I in this world, and what do I want to make of it?"★

Thom Elkjer is a freelance writer and reviewer living in Mill Valley. His novel, The Ones That Got Away, *will be published this year.*

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Election Night '96

by Roger Karraker

A television studio is a lot like the bridge of the Starship Enterprise. That's especially true for a live show like the evening news. With too much data to visualize, the commander—on TV they say "anchor"—gets information by questioning key subordinates. Meanwhile, off-screen technicians attempt to match on-screen graphics with the voiceover commentary. To avoid a comedy of errors—mismatched audio and video, lagging updates, mindless and pedestrian graphics—in a fast-breaking story such as a presidential election, technicians must lay crucial behind-the-scenes groundwork.

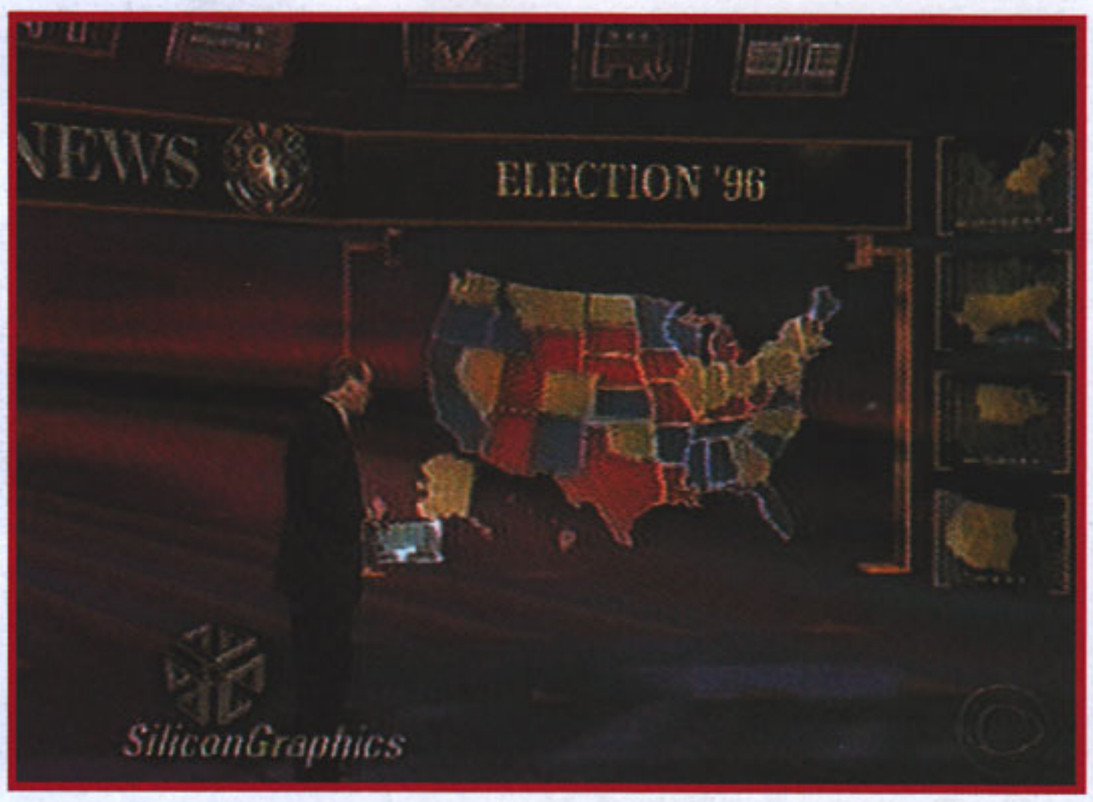
The Enterprise bridge is fiction, but that verbal and visual maelstrom—and occasional comedy of errors—has been a reality of TV news-in-the making. Or it was, until Election Night 1996, when all three major American networks used sophisticated arrays of networked Silicon Graphics computers to dramatically demonstrate that, for TV news, the new millennium has started a few years ahead of schedule.

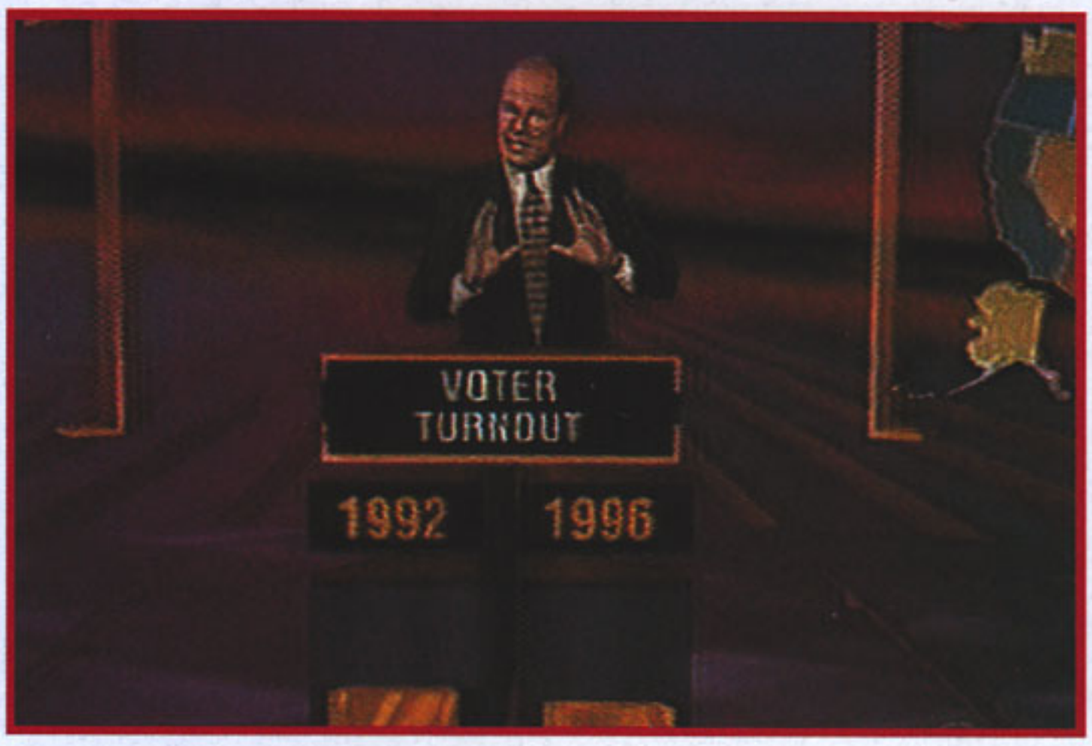
Election news on TV now features news anchors making instantaneous, unscripted decisions about what information to access when, in what manner, and at what length. It's a scene that, in its fluid spontaneity, has much in common with a session on the World Wide Web. Anchors have more of a role in choosing which races to report, in what order, with essentially no delay between vote counting and display.

On-screen graphics used to be static, analog displays—in essence, slides shown on TV. The analog days are over; they've been replaced by real-time computer images. On election night, viewers saw totals updated on-the-fly and charts changing with new data the instant it was received—thanks to wicked-fast computers, powerful graphics software engines, and geographically distributed Web servers.

Digitization has arrived in full force. The buzzword in media and telecommunications circles in recent years has been "convergence"—the long-awaited day when television's and telephony's cumbersome production tools would be replaced by awesomely powerful real-time computers. As the theory went, all the discrete, formerly incompatible media types—sounds, images, text, video—would converge into "digital glue," that is, indistinguishable bits and bytes stored in computers. These digits would be highly "malleable," as Nicholas Negroponte, director of MIT's Media Lab, describes it—easily converted to any output medium, whether broadcast video, audio, print, or electronic Web sites. Election Night 1996 illustrated just how that malleability could be put into play.

All three networks used Silicon Graphics computers to crunch vote totals and instantly convert the hard data into arrest-





Top: Harry Smith of CBS rehearses on the virtual set, powered by Silicon Graphics. Middle: Smith interacts live on election night with the Election '96 virtual set. Bottom: Smith compares voter turnout rates using the virtual set to help demonstrate. All imagery courtesy of CBS News.

ing real-time broadcast graphics. Two of the networks, ABC and CBS, went further, using sophisticated "cybersets," cousins to virtual reality environments. Unquestionably the sexiest technology on display election night, the cybersets looked like nothing seen before on TV news. Correspondents appeared to be surrounded with election data—bar graphs of voter exit polls in the crucial North Carolina Senate race, for example, juxtaposed against real-time vote counting. In reality, the correspondents were on bare blue-screen chromakey sets. To the cameras, everything photographed in blue can be instantly replaced by any other electronic image. In this case it was Silicon Graphics real-time graphics. The "sets" viewers saw were interactive data and 3D graphics combined in Silicon Graphics computers, apparently miraculously synchronized to the anchors' unscripted movements around the set. The correspondents were seemingly able to conjure up visual data and interact with it in real time. Where real sets are static, the cybersets are fluid. Correspondents could, with a gesture, summon charts, graphs, and photos to "grow" out of the floor, could zoom or magnify them on command, then dismiss them, Merlin-like, with the flick of a hand.

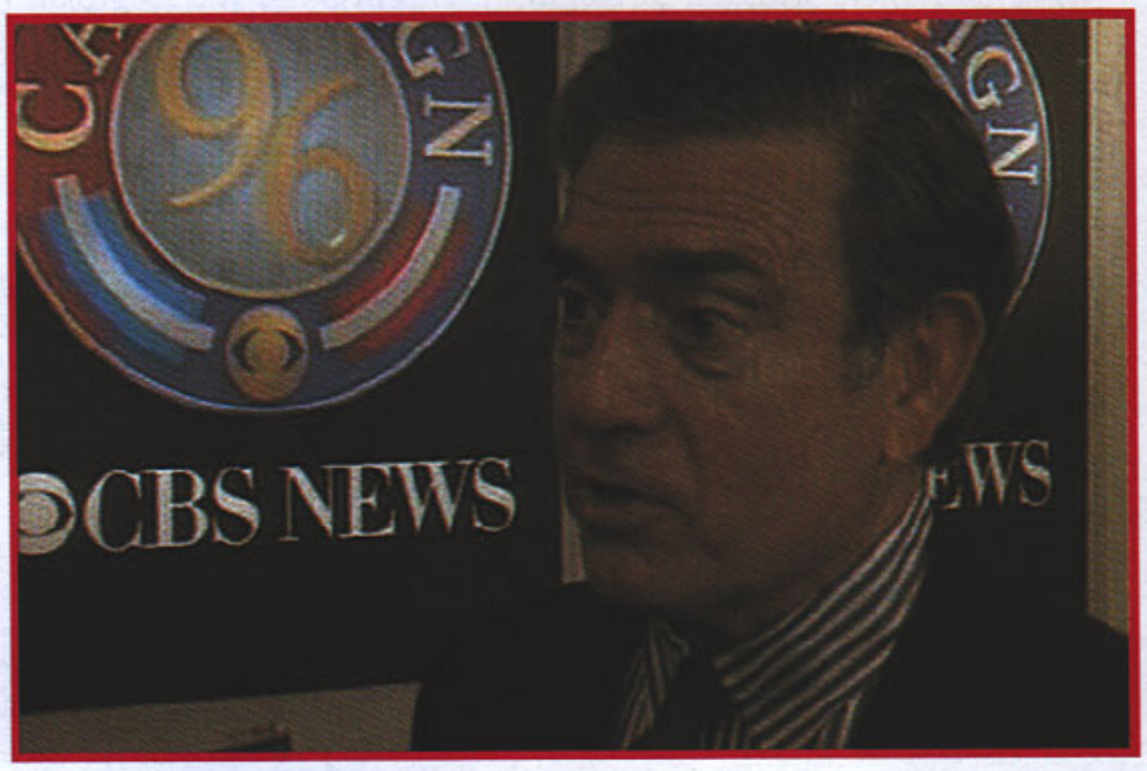
To produce this apparent sleight-of-hand, the computers were linked to the studio cameras, measuring their position, angle of view, focus, and motion. The data received from the cameras interacted with the coordinates of the cyberset, stored in the computers, so that when, say, CBS correspondent Harry Smith moved about the set, he appeared to be surrounded by physical and data objects—all of which was, "in reality," spinning off hard disks on Silicon Graphics computers.

Virtual set technology is being closely watched by television producers. Traditional sets are expensive to design and build, take up valuable studio space, and are excruciating to change. Virtual sets, though, can be altered as easily as one switches a hard disk or a DAT drive.

ABC director Hal Aronow-Theil says that a new dimension is dawning in television news. "You're unlimited with where your imagination can go: you can have virtual desks come up, and virtual chairs, things that don't really exist anywhere; you see your correspondents in this environment, and they are interacting with things." CBS carried that interaction even further, simultaneously pumping the same data and graphics in real time to Silicon Graphics WebFORCE Web servers in three locations across the country. The servers, in turn, were visited by hundreds of thousands of impatient news junkies craving their real-time election night fixes.

Thus, visitors to www.cbsnews.com had access to the same data and most of the same graphics as CBS' on-air talent—at the same time. The difference, of course, was that the Web surfers had individual control over what they saw, heard, and read. In effect, CBS News was "parallel-casting:" one fixed data stream for broadcast viewers, an interactive stream, drawing on much of the same data, for Web surfers.

Here's how it worked. CBS' in-house SQL database server was updated about 100 times a second with new information from Voter News Service, the vote tabulating organization used by the three networks. Election results and HTML pages and GIF images were passed to a Silicon Graphics server for CBS' 200 local affiliate stations.



Rehearsing for election night coverage, CBS' Dan Rather controls graphics with a touch-screen monitor.

The affiliate server also created dynamic HTML pages, then passed those elements to the main CBS server located at Icon, CBS' ISP, and to two mirror servers located at the Internet crossroads MAE-West and MAE-East. The three CHALLENGE dual-processor servers had been preloaded with static pages and images, so only dynamic data needed to be sent. Single-processor CHALLENGE servers were arrayed alongside, in a "fail-safe" configuration.

As CBS' Dean Daniels put it a few days before the election, "you can watch the television broadcast part of our election coverage, and you can also have your Web browser open on your computer, and if Dan Rather doesn't happen to be talking about North Carolina at the time you want to know about North Carolina, you can just click on North Carolina on the

big CBS national map and find out that information. It gives the user much more control in addition to what they can see on the broadcast."

To be honest, CBS had some trepidation, says Steve Jacobs, the executive producer for special events. An election experiment years back with telephone access had not gone smoothly: callers to CBS jammed all the lines into a Midwest metropolitan area for hours, bringing the phone system to a crawl. It's an old newsroom saying that "Murphy was an optimist."

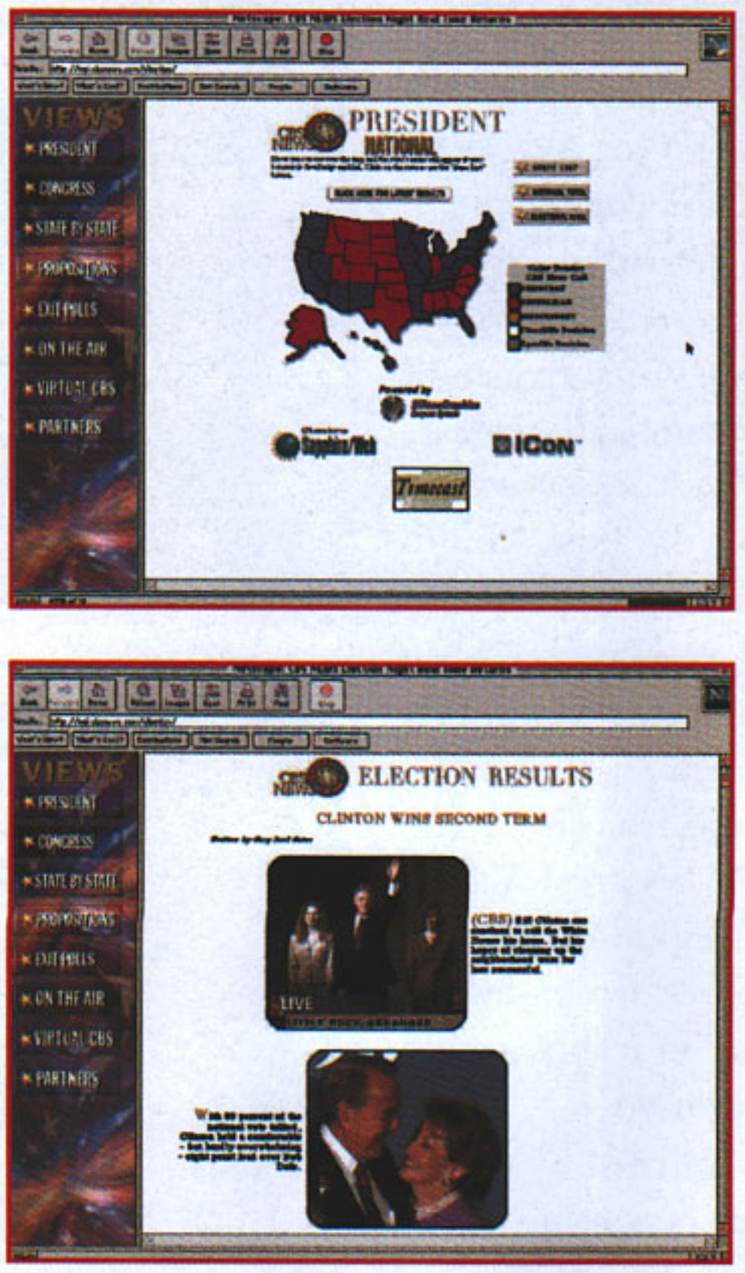
But 1996 was quite different. The Silicon Graphics servers handled an unprecedented demand: more than 11 million hits in a single day, five straight hours with more than 1 million hits per hour, even a two-hour peak with more than 1.4 million hits per hour. One server did, in fact, hiccup. And, as planned, the backup server alongside came on line on cue. Of equal importance, the database server—Web server configuration designed by Silicon Graphics' Dan Baca and his team won plaudits from CBS' 200 affiliate stations around the country. One news director told CBS' Steve Jacobs that he was able to get local election data from CBS' affiliate server long before he could get it from his own state's election officials.

On the day after the election, one much-discussed topic was the previous night's occasional Internet traffic jams. There were only occasional bottlenecks, though, and then only in isolated spots. For example, when Internet service providers downstream of CBS' servers were occasionally overwhelmed on the routes to the MAE-East and MAE-West servers, savvy users switched to the Midwest server and got right through. Despite the headlines, a majority of online users informally surveyed the next day reported that they had found no difficulty accessing the major election Web sites.

While Web users browsed the data, TV viewers got to see Dan Rather working as a 21st century newsman: anchorman as *uber*-browser. On election night, with a camera overhead focusing on his hands, Rather deftly tapped an ever-changing color-coded map on his touch-screen monitor, instantly pulling up real-time graphical election results on every major contest in the nation. His touch-screen maps were loaded with graphics for the presidential race by state, and for 50 other key Senate, House, and Proposition races. He could click on a state, then zero in on a race or an issue, and instantaneously receive a 3D graphic with updated figures and a dynamic bar chart.

It was Rather, not his off-screen producers, who decided what information to display, and when. It's an important power shift, illustrating once again how digital computers can move control closer to the creators. Like the Web, the TV news world of the very near future will interpose far fewer intermediaries between the searcher and the information. "For the first time, our anchor will be able to call up specific graphics at the touch of a finger," says Steve Jacobs. "It's every anchorman's dream—to produce his own broadcast."

For a newsman like Rather, this shift results in a better news show. "I never imagined I would do election night coverage with this much control of the graphics literally at my fingertips. I think we'll make fewer mistakes like having the wrong graphic or the wrong map up," Rather said on the eve of the election.



The CBS Web site handled 11 million hits on election night over as period of five hours. The Web site was powered by Silicon Graphics Servers.

ABC and NBC also employed Silicon Graphics InfiniteReality computers to prepare real-time graphics for broadcast. "This is the future for us," says NBC producer Guy Pepper. "This technology is long term; this is the future of graphics."

As recently as the last presidential election in 1992, real-time 3D graphics weren't quite ready for prime time. The then top-of-the-line Silicon Graphics Onyx could manipulate 1 million polygons per second—a phenomenal amount, but still a stretch for the requirements of TV news. Four years later, the Silicon Graphics InfiniteReality^2 computers are 10-times as powerful, and network news and graphics chiefs are enchanted.

"You have infinite possibilities around where to go with this design," says ABC's Aronow-Theil. "What we've discovered is that it's much, much faster. We can tie our Voter News Service [exit polling] directly into the Silicon Graphics workstation and change ports instantly. What the InfiniteReality does is give you the unlimited resource and power to dream, to just do whatever you want to do."

Well, *almost* anything you want to do. There's one glaring omission: remember those ABC and CBS correspondents on their cybersets, surrounded by virtual data and graphics? None of that was available to Web site users. Neither our home computers nor the Internet's pipes can move data quickly enough for us to manipulate a million polygons per second. But Silicon Graphics is hard at work on overcoming those limitations, too. It gives us a reason to look forward to election night 2000.

Roger Karraker (roger@river.org) writes about telecommunications, multimedia, and public policy for MacWeek, MicroTimes, Networker, Digital Advisor *(Tokyo), and other publications. He is the co-author of* Digital Revolution in the USA *(Tokyo: 1994).*

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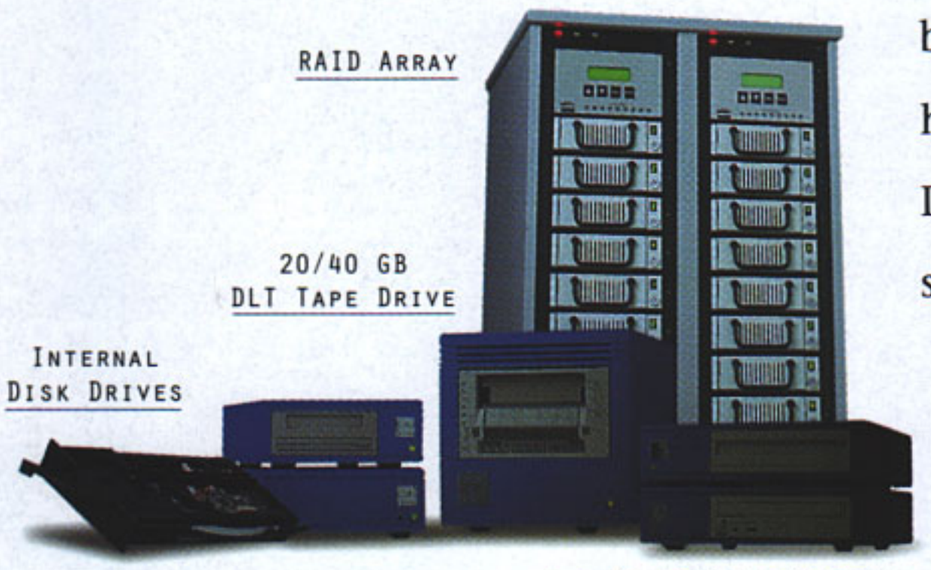

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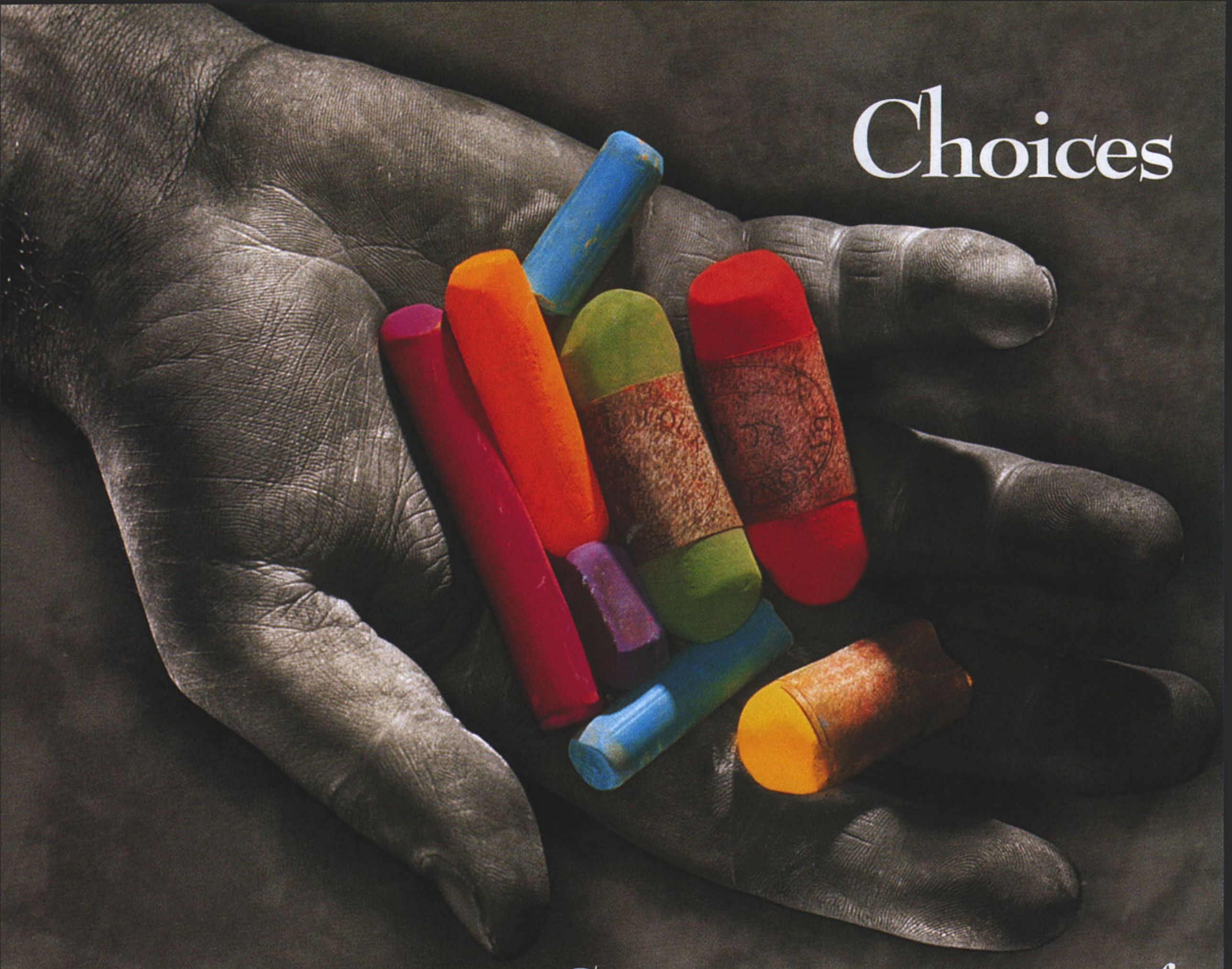

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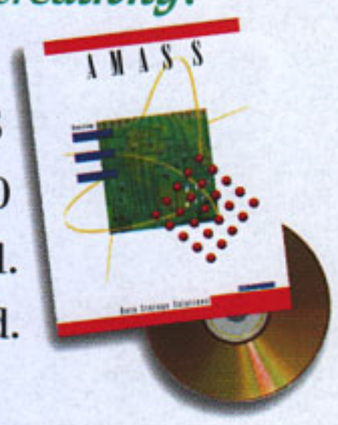

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CIRCLE READER SERVICE CARD NUMBER 21

The Future of On-Line Information Delivery: A Cybrarian Reflects

by Reva Basch

In the summer of 1989, a group of activist librarians—no, that' s not a contradiction in terms—gathered in Santa Barbara. Their mission: to change the on-line industry.

Presumptuous? Not really. "On-line," eight years ago, referred to a collection of industrial-strength text database services—Knight-Ridder/Dialog, Lexis-Nexis, and Dow Jones News/Retrieval are surviving examples—electronic libraries consisting of digitized articles, government documents, and scholarly proceedings, used mainly by librarians and researchers. The Santa Barbara meeting was not a tail-wagging-the-dog exercise.

On the sidelines were consumer on-line utilities such as CompuServe and The Source, where folks could exchange e-mail and participate in discussion groups on everything from cultivating orchids to raising kids. Such services were strictly text-based, driven by keyboard commands and populated largely by people with at least a hobbyist-level interest in computers to begin with. These early adopters got a foretaste of what many say is the Internet's killer app—the ability to communicate at will with others.

The Internet occupied an even more obscure corner of the on-line universe, where scholars and academicians, government researchers, and hard-core computer enthusiasts exchanged data, manuscript drafts, and intellectual bon mots. The Net was not yet a blip on the general public' s radar screen, let alone the all-pervasive multimedia environment it is today.

The on-line world at the dawn of this decade was fragmented and isolated, with very little crossover among the database research, consumer, and academic segments. Nobody foresaw the possibility of synergy among those diverse components.

The Santa Barbara meeting resulted in a manifesto called the User Wish List. Among other things, it called for the ability to display graphics as well as text, to hyperlink from document to document, to search electronic library collections using plain English instead of esoteric incantations, and to access the entire range of potential information sources, seamlessly and universally.

Imagine Our Surprise

The librarians eventually got what they'd wished for, but not from the traditional information providers they'd petitioned. By 1994, two newcomers, America Online (AOL) and the World Wide Web, were steadily strengthening signals on the radar screen of the average wired American. Both were infinitely prettier, cheaper, and easier to use than the industrial-strength database services. Each one presented a new model for information delivery.

Instead of databases loaded with undifferentiated text, AOL introduced a virtual village model: at the core was a single city newspaper or a periodical such as *Time* magazine. Users could browse current stories and search back issues by key word. Equally important, they could take part in discussion forums, interacting with other readers, staff writers, and occasional celebrity guests. Augmented with notices of events, both on line and off, that mapped to users' geographic areas or subject interests, AOL publication clusters sometimes took on a life of their own, a distinct sense of place.

For all its shortcomings as a serious research environment—sources tend to be widely scattered and must be searched laboriously, one-by-one, with a limited key-word search engine—AOL broke new ground in on-line information packaging and delivery. Its "cluster" model, attractively wrapped in a graphical, point-and-click interface, combined traditional print and electronic publishing, enhanced by the participation of a virtual community based on shared interest.

Enter the Web

As America Online gathered its constituency, the World Wide Web, energized by the introduction of Mosaic—the first widely available graphical browser—fueled the information delivery revolution on other fronts. There was a surge in do-it-yourself publishing efforts—too many home pages, to be sure, that squandered bandwidth on photos of the kids and pets, but also some dramatic examples of the power of the press.

Web publishing has reduced concepts like "lead time" and "production cycle" to a single phrase: "Just do it." As a result, content is uneven, often unreliable, and largely uncontrolled. Publishing conventions such as peer review, editorial standards, and fact-checking are the exception rather than the rule. As a research medium, the Web is disorderly to the point of chaos, and the much-hyped Web search engines—even the deepest, broadest, most macho of the breed—are blunt instruments compared to the surgical precision of Dialog or Lexis-Nexis, with their Boolean AND/OR operators and other powerful and flexible options for fine-tuning a search.

What the Web does offer is serendipity. Its loose, associative fabric encourages the lucky find, the equivalent of picking up a book on the library shelf next to the one you were looking for, that turns out to be even better. The hyperlinks that stitch the Web together are created, for the most part, by human beings, who see the subtle, indirect, and non-obvious connections among facts, ideas, and documents that a Boolean search engine, relentlessly literal, can' t be programmed to recognize.

In practice, hyperlinking raises some knotty legal and ethical questions: what happens when a manufacturer's shiny, expensive new marketing site is linked to an environmental group's list of corporate polluters, or a professional woman's on-line resumé, complete with photo, is linked to a "Babes on the Web" site? Viewing a document in any context other than the original changes its meaning. What control should its creator have over such unintended shifts and alterations? How do we assign intellectual property rights in such a strongly collaborative medium? Copyrighting, too, is a hugely complex issue, hotly debated Web-wide, and nowhere near resolution.

The Personal and the Social

The next phase of on-line information retrieval is starting to play out in two different arenas—the personal and the social.

Personalization is one response to information overload. We've begun to realize that we can no longer cover the entire Web, nor should we have to. A variety of solutions is coming into play, including intelligent agents trained to learn your needs and do your bidding ("George, how did my stocks do overnight? What's the traffic like on I-80? Would you get me movie reviews for everything good that's playing in my neighborhood?").

Visitors to the Firefly site (www.firefly.com) can register their favorite books, movies or music groups, then be steered toward new options that they may not have heard of, but that people with similar tastes have indicated they've enjoyed. It's like getting an opinion from someone you know and trust. Some future release of a Firefly-like agent will learn exactly what you mean by a "good" movie, and will act accordingly.

Agents, also called 'bots—short for robots—or 'droids, as in androids—might also play a role in an information-gathering paradigm that's come to be called, generically, The Daily Me. That's shorthand for the ultimate personalized newspaper, selecting and prioritizing the information that you've indicated you want to see. MIT's Media Lab is working on delivering your morning newsfeed environmentally—through the soles of your bedroom slippers, or projected on your kitchen wall, or on the inside of your eyeglasses as you walk to the bus.

Meanwhile, dozens of Web-based services offer some degree of filtering and customization. Individual, Inc.'s NewsPage line delivers current, targeted information via the Web, by e-mail, or even off line. Netscape has introduced Inbox Direct, a customized news feed, with information drawn from the *New York Times* and other top-notch sources, that provides HTML-ized content, with live links, through the browser's e-mail reader. Pointcast, partnering with content providers such as CNN and Reuters, turns real-time news and financial market data into a screensaver display that's considerably more informative than flying toasters or Windows 95 logos in freefall.

Convenient? No doubt—but filtered information services don't adequately address the "randomness" factor: You don't know you need it until you see it. When you open your daily newspaper, you register, subconsciously, even those stories that you elect not to read. Occasionally, something catches your eye—an unexpected blip in the stock market, a technological breakthrough, the death of a public figure—that may change your day, perhaps your life. Any customized information service that doesn't account for chance can't claim to be the ultimate answer to an info-junkie's prayers.

Another potential downside is the dissolution of a common frame of reference.

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CIRCLE READER SERVICE CARD NUMBER 22

Today, most of us meet our minimum daily information requirements with a core group of newspapers, magazines, and broadcast radio and TV. We supplement that baseline awareness with a variety of other, more specialized sources, but a shared experience of what goes on in the world we all inhabit is part of the social glue that holds the human race together.

The Global Brain

For the technologically adept, the Net has become an alternative, often preferred, information channel. Like radio and TV, it reaches millions of people simultaneously. News circulates even more rapidly on line—time zones are irrelevant because somebody is always logged in. The Internet never sleeps.

High-mileage Net-travelers sometimes describe it as a global brain, a collective consciousness pulsating with a single thought. Never is this more apt than when a big story is breaking. Witness Tiananmen Square: on-the-spot descriptions of an event halfway around the world were pumped simultaneously, through billions of electronic neurons, to newsgroups and other on-line worldwide forums. If you happened to be on line that day in June 1989, you might have heard about the pro-democracy demonstrations as they happened.

What you heard would have been significantly different, too, from the reports that eventually appeared in the print and broadcast media—eyewitness accounts, background and analysis from informed local observers, uncensored commentary from those without a party line to defend, as well as from disenfranchised representatives of seldom-heard points of view.

Linguist and social critic Noam Chomsky condemned the mainstream media for fostering what he called "manufactured consent," painting a rosy and often biased picture of the status quo, reinforcing public complacency while stifling dissent. "Manufactured consent" is impossible on line; the medium is incapable of consensus. There is no central authority, no universally respected dispenser of wisdom. (Quite a few media gurus do, in fact, hang out on line, but their opinions carry no more weight, Net-wide, than anybody else's). The very concept of "authority" is a curse to the Net.

The Net encourages narrowcasting, an infinite range of programs, most of them created without a thought for market share or advertiser appeal. Thanks to the Web, we are all commentators and publishers. The power of the press—and of the broadcast transmitter—now belongs to everyone.

The Printed Wor(l)d

Zines—edgy, crudely produced periodicals, with names such as *Drop Dead*, *Noir,* or *Mutant Barbie*—migrated from print to the Web as if this new publishing platform had been designed with them in mind. Zines (truncated from "magazines") are even cheaper to produce and distribute on line than in print, and the Web adds multimedia possibilities—images, animation, video, and sound clips—that would be prohibitively expensive to replicate in any other medium.

On line and off, zines cater to minority viewpoints—subcultures, attitudes, demographic and special-interest groups usually ignored by the mass-market media. In an essay entitled "The Social Life of Documents" (www.firstmonday.dk/issues/issue1/documents/) John Seely Brown and Paul Duguid describe how zines allow "scattered groups of people unknown to one another, rarely living in contiguous areas, and sometimes never seeing another member . . . to form robust social worlds."

More polished, professionally produced e-zines like *Salon*, *Stim*, and *Slate* are reshaping the genre, transforming it from a countercultural phenomenon to a mainstream model for Web-based publishing today.

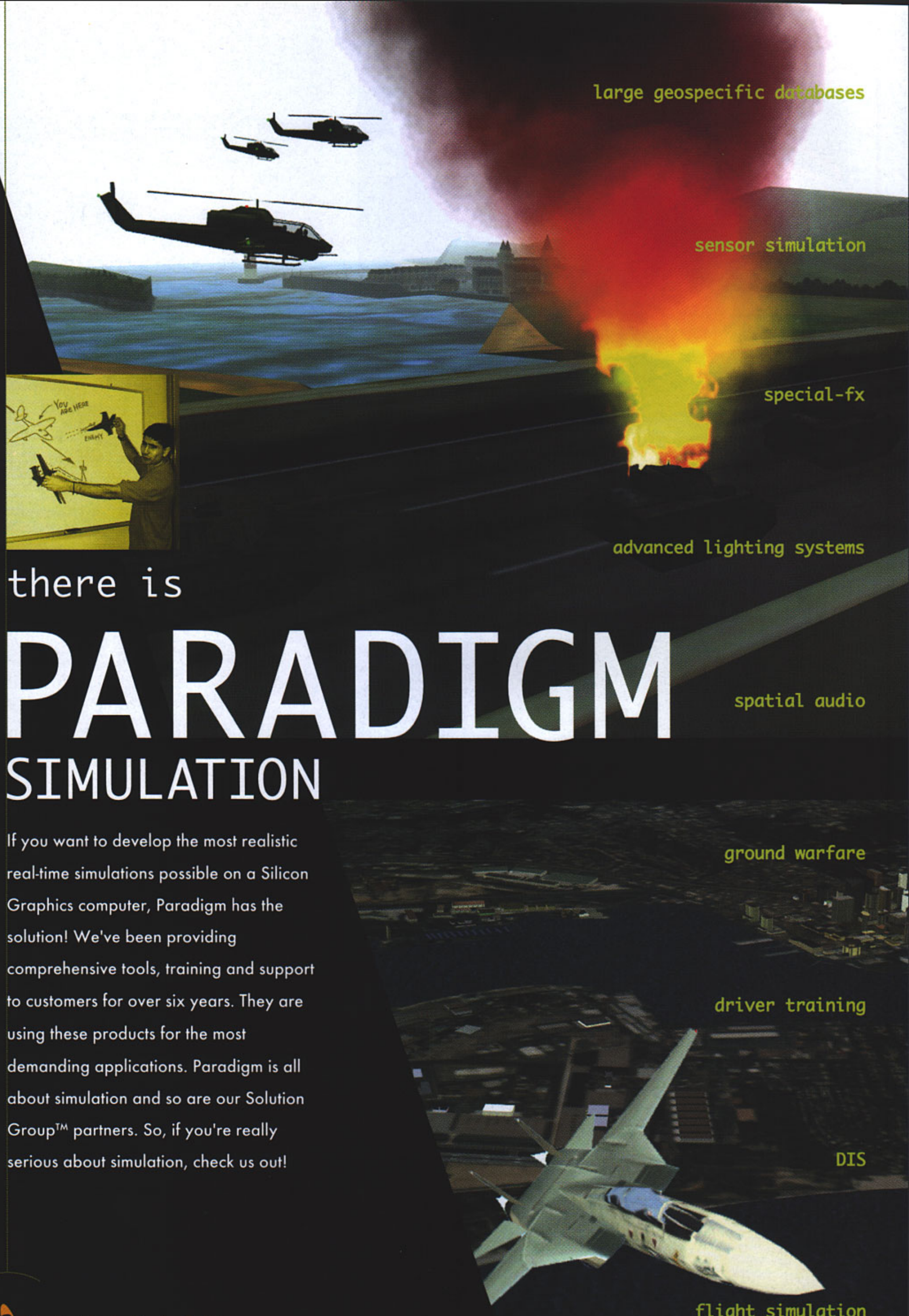
In a looser, more vigorous variant of AOL's publication-cluster model, zine readers talk back to the staff and to each other, forming alliances and enmities, adding new perspectives. Lines are blurring everywhere—between reader and writer, between core content and added commentary, between the editorial voice and vox populi. Publishing is becoming a rolling, collaborative effort.

Community as Content Provider

On-line communities may be the next wave of information publishing. Myriad virtual neighborhoods have sprung up and flourished, even without a zine-seed at their core. The richest and most robust of these developed and continue to thrive purely on the strength of their conversational and informational quality.

The Internet holds unlimited opportunities for on-line interaction. Usenet newsgroups, pioneering virtual communities such as The WELL, Web-based conferencing systems such as Electric Minds, and virtual domains like MUDs and MUSEs (most of them text-based, but with both 2D and 3D graphical modes emerging, many of the latter based on Silicon Graphics' VRML standard), foster both general and special-interest communities based on everything from *Star Trek* fandom and C++ programming to health-care advocacy and political reform.

Talk is fleeting, but typing leaves a trail, a written record that lasts—depending on the archival practices of the host system—for days, weeks, or forever. Active participants can ask questions and receive answers, often in real time, before they log out. Latecomers or data-miners in search of specific information can examine the archives and gather what they need, post facto. The size of the Net population and the intelligence it embodies is, in itself, an extraordinary information resource.



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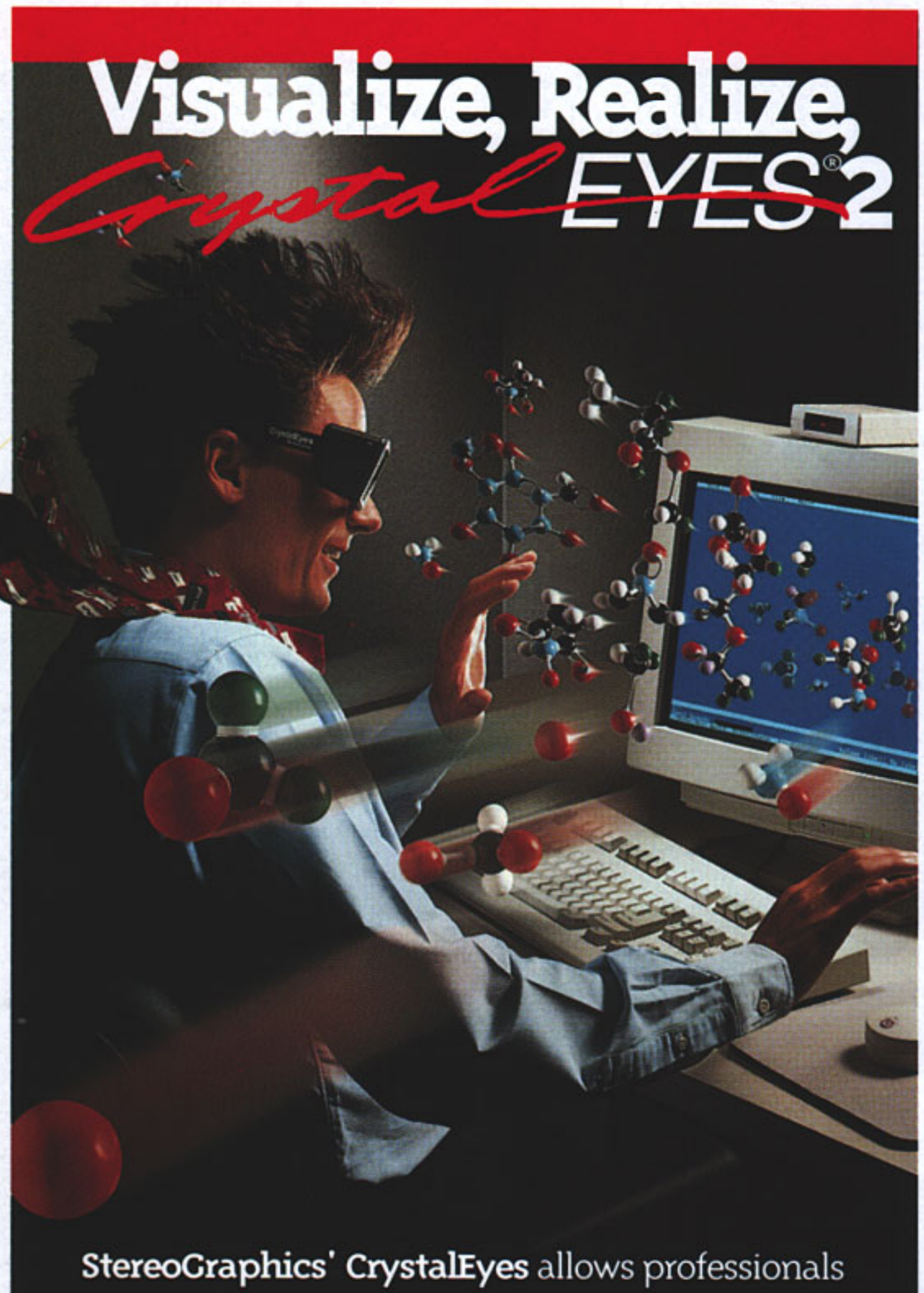

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CIRCLE READER SERVICE CARD NUMBER 24

Up Next...?

The revolutionary changes in the on-line world since the beginning of the '90s—the merging of the three separate realms that existed in 1989, and especially the synergies enabled by the emergence of the World Wide Web—have stretched, smashed, and otherwise rendered obsolete many of our assumptions about the nature of information, publishing, and research.

Paul Saffo of the Institute for the Future in Menlo Park, California, likened the current phase of publishing on the Web to the early appearance of plastic in consumer goods. When plastic was first used—in combs, eyeglass frames, radio cases—it was made to resemble older, more familiar substances—tortoiseshell, woodgrain, ivory, or bone. It wasn't until the marketplace was comfortable with the new material that manufacturers began to explore fresh possibilities—turquoise, transparent, speckled, metallic—new forms and variations made possible by the inherent plasticness of the medium.

Similarly, most current publishing attempts on the Web, despite their use of animation, streaming audio, and other multimedia effects impossible to achieve in print, are still based on a familiar metaphor—the print magazine. We have not yet emerged from the tortoiseshell-and-ivory age of electronic publication.

Deep down, the transformative power of the Web lies in its hyperlinking capabilities, its ability to connect related documents, concepts, and communities-of-thought in a free-associative, nonlinear, and highly creative way. The Web mirrors the way the human mind works—or did, before textbooks and curriculum outlines imposed the ideal of orderly, logical progression. No wonder it appeals to madmen, artists, and children.

What happens next, as the Web itself, our sophistication as Net-denizens, and external social, political, and technological forces continue to coevolve, is impossible to predict. Like those activist librarians who met to shape the future of their on-line industry, we are ultimately prisoners of our own perspective. Even the most visionary among us can only extrapolate from what we already know.

The next phase, whatever it is, is imminent and almost certainly irreversible; the Internet has no "off" switch. When we find ourselves using the new information media as much as we're currently musing about them, we'll know that the future has arrived. ★

Reva Basch is a writer, editor, and consultant to the on-line industry and is based on the northern California coast. Her most recent book, Secrets of the Super Net Searchers, *was published by Pemberton Press in October 1996.*

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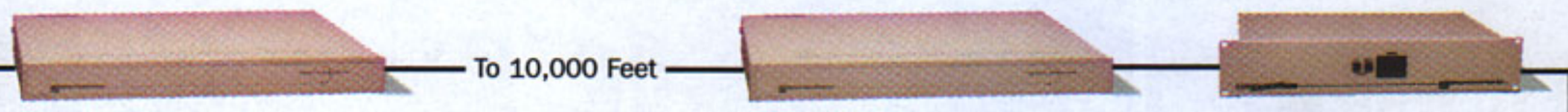

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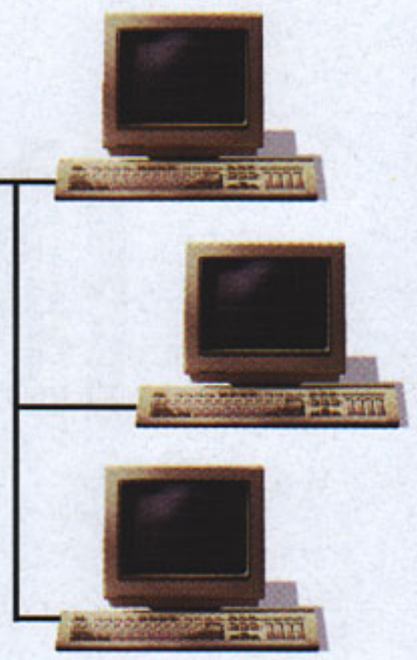

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CIRCLE READER SERVICE CARD NUMBER 26

HOW TO LEAP INTO THE WEB AND LAND SOFTLY

BY GRANT ELLIS

YOU KNOW THAT A WORLD WIDE WEB SITE CAN BE A POWERFUL MARKETING AND COMMUNICATIONS TOOL. BUT YOU NEED SOME BASIC INFORMATION ABOUT HOW TO GO ABOUT SETTING ONE UP. THIS ARTICLE IS FOR YOU.

To start with, we'll make some assumptions. You have a computer, a modem, and access to the Internet. You use them to send and receive e-mail and perhaps to access files. You know that the Internet is a network of private, commercial, governmental, and institutional computers linked by telephone lines, and that anyone can tap into it or contribute to its content. You know that the Web is the graphics-based part of the Internet, and you've been accessing it with a Web browser, such as Netscape. You're impressed with the way Web sites can present information, and you'd like to create one for your organization.

Where do you begin?

PUTTING A WEB PAGE TOGETHER

The basic language of the Web is HyperText Markup Language (HTML), an authoring language that Web site developers use to instruct Web servers to display visuals and text on the screen. Relax: you don't need to be a programmer to turn out professional-looking Web pages. No matter what hardware platform you use, there's software that will let you work intuitively with text and images in the kind of environment you're used to. When you're done, the program writes the HTML code for you.

The Silicon Graphics WebFORCE O2 workstation is the industry's most advanced example of this technology. It's an integrated Web authoring and publishing system that includes the Silicon Graphics Cosmo suite of tools, which lets you design your Web pages without thinking about code. Cosmo Create, one component of the suite, provides the ultimate in Web page layout tools. It gives you a comfortable WYSIWYG graphical interface and utilities that make it easy to create tables, image maps, frames (used to set off sections of your page for different purposes), and forms (including text fields, radio buttons, drop-down lists, and pushbuttons). Cosmo Create also gives you a way to add photos, video, audio, 2D or 3D graphics—virtually anything that can be digitized—to your page.

Suppose you want to animate something on your Web page. Cosmo Code, another Silicon Graphics Web authoring tool, lets you use Java, a Web-oriented programming language, to set things in motion and make them interactive. Of course, you don't have to write Java code; Cosmo Code does that for you. Java programs are really mini-applications that are downloaded and activated when someone visits and interacts with your Web page.

As your knowledge and expertise continue to grow, you may decide to use Virtual Reality Modeling Language (VRML) to

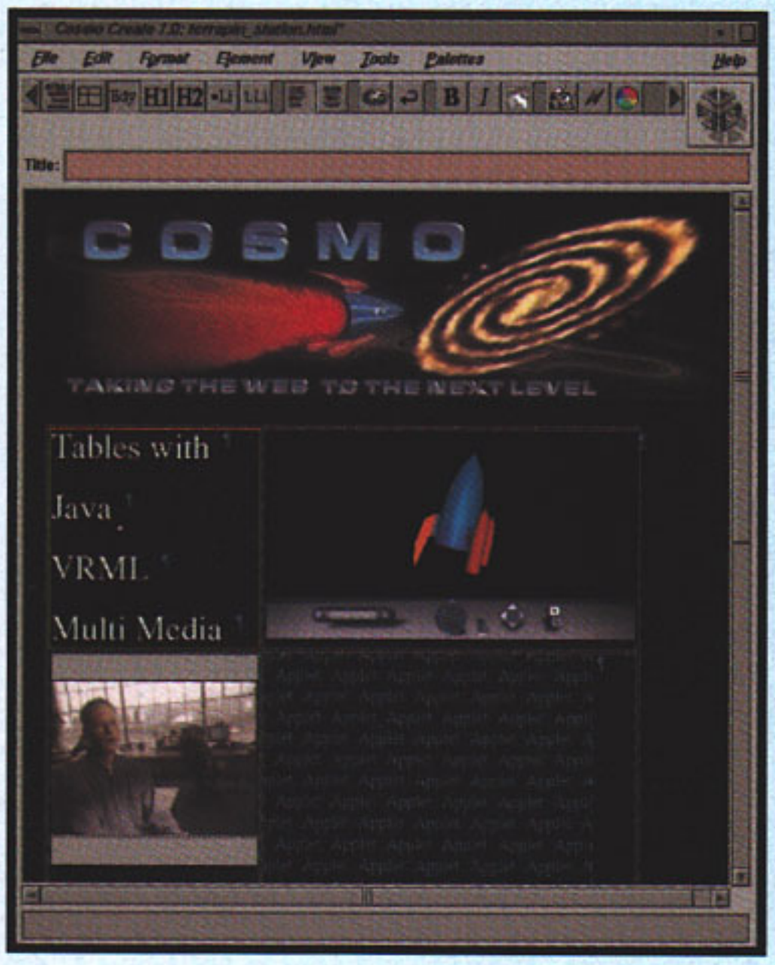
publish your own virtual world on the Web. Cosmo Worlds, another Silicon Graphics Web authoring tool, lets you use VRML to create an interactive 3D world in which your visitors navigate by means of a keyboard or mouse. The idea of creating a custom virtual environment in which your visitors can move about at will may seem remote to you today. But companies and institutions are already using this powerful idea to sell and motivate. And when you're ready to make that move, Cosmo Worlds will provide the tools.

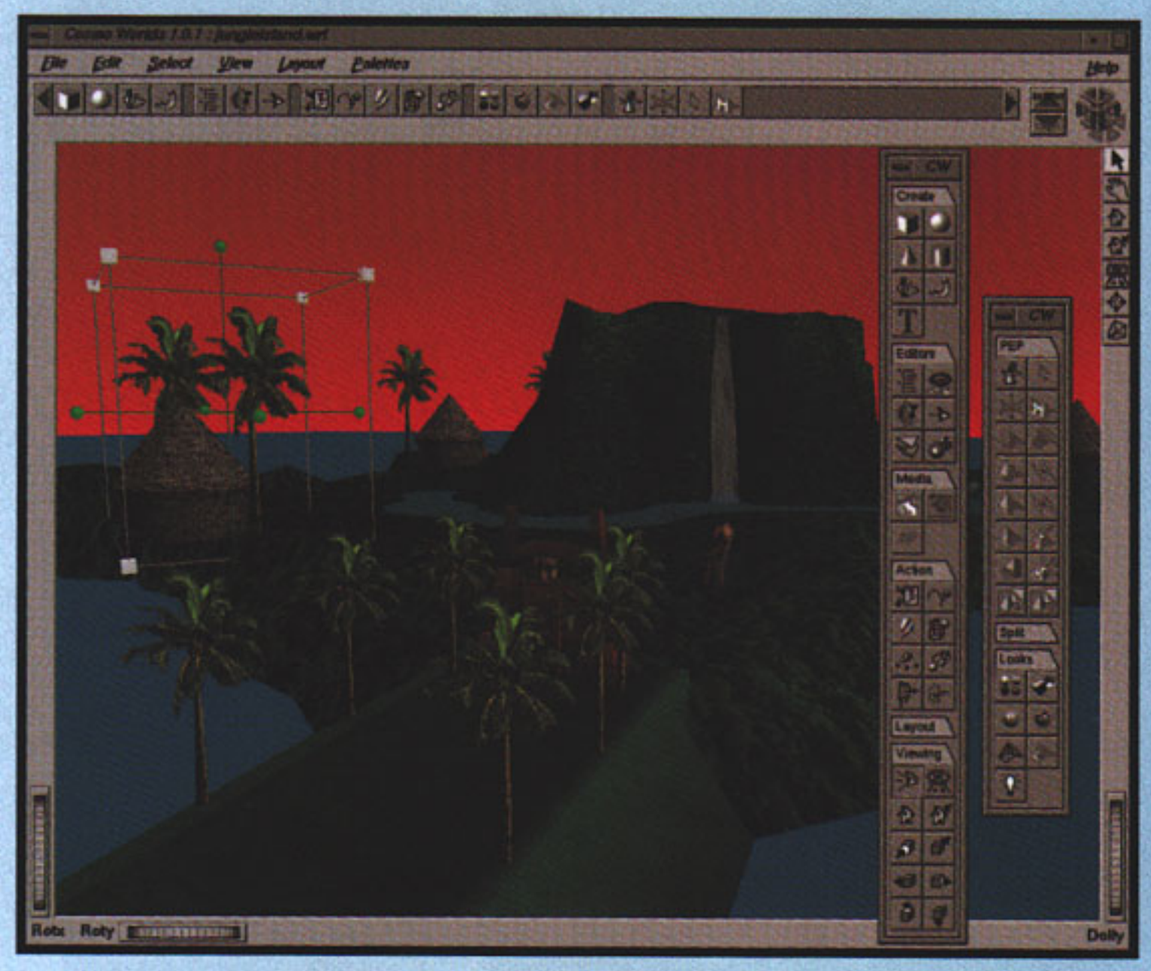
DESIGNING YOUR OWN WEB PAGE

When you do sit down to put together a Web page, give your first consideration to the why of all this. You have a message for your visitors, and you want them to stick around, explore your Web site, and absorb what you have to say.

The first thing, then, is to be clear and direct. Get to the point on the first page. Emphasize the important things. Tell them who you are and what you're doing, and be sure to put contact information on the first page. Then, give them reasons to stay at your site, a choice of areas to explore next. Help them find what they're looking for, and always give them a way to jump from one major section to another, or back to the top of the page.

You can make all this visually exciting, but be sure to keep it simple and tasteful. There are so many dazzling possibilities that it's easy to get carried away: too many colors (or colors that scream at each other), too many frames and horizontal rules,





At left: Users can create 2D HTML Web pages using the Cosmo Create, Web authoring tools from Silicon Graphics.

At right: "Jungle Island" is a 3D VRML world created using Cosmo Worlds, a 3D VRML authoring tool from Silicon Graphics.

graphic elements, things that blink or move, flocked-wallpaper backgrounds that make your eyes water. Strong, clean designs get your message across most effectively. Use your visual excitement sparingly; it will have far more impact. Don't make your page so busy that it confuses instead of communicates. Less is more; clean is cool.

A word about type: keep it simple. If you use type in several fonts, sizes, styles, and colors, you are sure to be stamped as a novice or an amateur. You will also make your visitors' eyes glaze over—if they stick around that long.

More than anything else, it's the visual excitement of graphics that will make or break your Web pages. But don't test your visitors' patience. If you use big graphics, or too many frames, your page will take so long to display that they may tire of it and go elsewhere. It's particularly important for your first page to come up quickly.

What will keep your visitors coming back? Not the excellence of your site design, but the assurance that there will be something new to see. You need a program of regular updates, with new information, new visuals, new departments, new something. Once you've got them coming back, don't let them down.

PUBLISHING YOUR WEB PAGES

Now, then. You've come up with a page layout that is classic, clean, and powerful. Your content is prepared; your text is written, your graphics files are at hand, your videos are in place. How do you get all this out to the public?

After you've used Cosmo Create and Cosmo Worlds to design your Web pages, you can mount them on a server, a computer connected to the Internet and the rest of the World Wide Web, where users with Net connections of their own can see them. One of the beauties of the Web is that visitors with Web browsers will be able to display all your content—the end result of all that HTML and Java code—whether they're running PCs, Macintosh computers, or UNIX workstations. Visitors using Netscape Navigator as a Web browser on their PCs can download Cosmo Player (a Netscape plug-in) from the Silicon Graphics Web site to enjoy your VRML worlds without having to buy 3D graphics acceleration hardware.

Back to the question of getting your Web pages out to the public. The approach you take will be affected by many factors, including economics and the level of traffic you expect. Here are three possibilities:

Use your O2 workstation as a server. The Silicon Graphics WebFORCE O2 authoring/server workstation gives you a turnkey authoring/serving solution—the industry's first integrated solution. It includes the full suite of Cosmo authoring/publishing tools, plus software from Netscape and Adobe.

Use your Internet Service Provider's (ISP's) server. You can set up your Web site on your ISP's hardware, which relieves you of maintenance and equipment concerns but takes control of the system out of your hands.

Set up your own full-blown server. Silicon Graphics WebFORCE Origin servers give you scalable turnkey multiprocessor systems that let you start at any traffic level and grow all the way up to a 128-processor system. Origin servers include the full complement of administrative and system setup tools so that you can take advantage of all the industry's best utilities.

To sum up: using the Silicon Graphics Cosmo Suite and WebFORCE authoring and serving systems, you have the power to author and publish Web content using the industry's most advanced tools. Follow some simple aesthetic guidelines, and you can create text and visuals that are powerful and effective—and that keep your visitors coming back for more. ★

Grant Ellis (gellis@redshift.com) writes on a wide range of technical subjects. He works from his Pacific Grove, California, home.
Page 63 image created by Rick McKee. Car data set courtesy of Viewpoint Data Lab.

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- ❑ Entertainment
- ❑ Film/Video
- ❑ Games
- ❑ Lithography
- ❑ Multimedia
- ❑ Virtual Reality
- ❑ Other Creative Graphics

Building/Construction
- ❑ Architecture
- ❑ Engineering
- ❑ Other Building/ Construction

Government
- ❑ Dept. of Defense
- ❑ Dept. of Energy
- ❑ Dept. of Trans.
- ❑ Health
- ❑ NASA
- ❑ Other Government

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- ❑ Automotive
- ❑ Computing
- ❑ Petroleum
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- ❑ Textiles
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Research
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- ❑ Pharmaceutical
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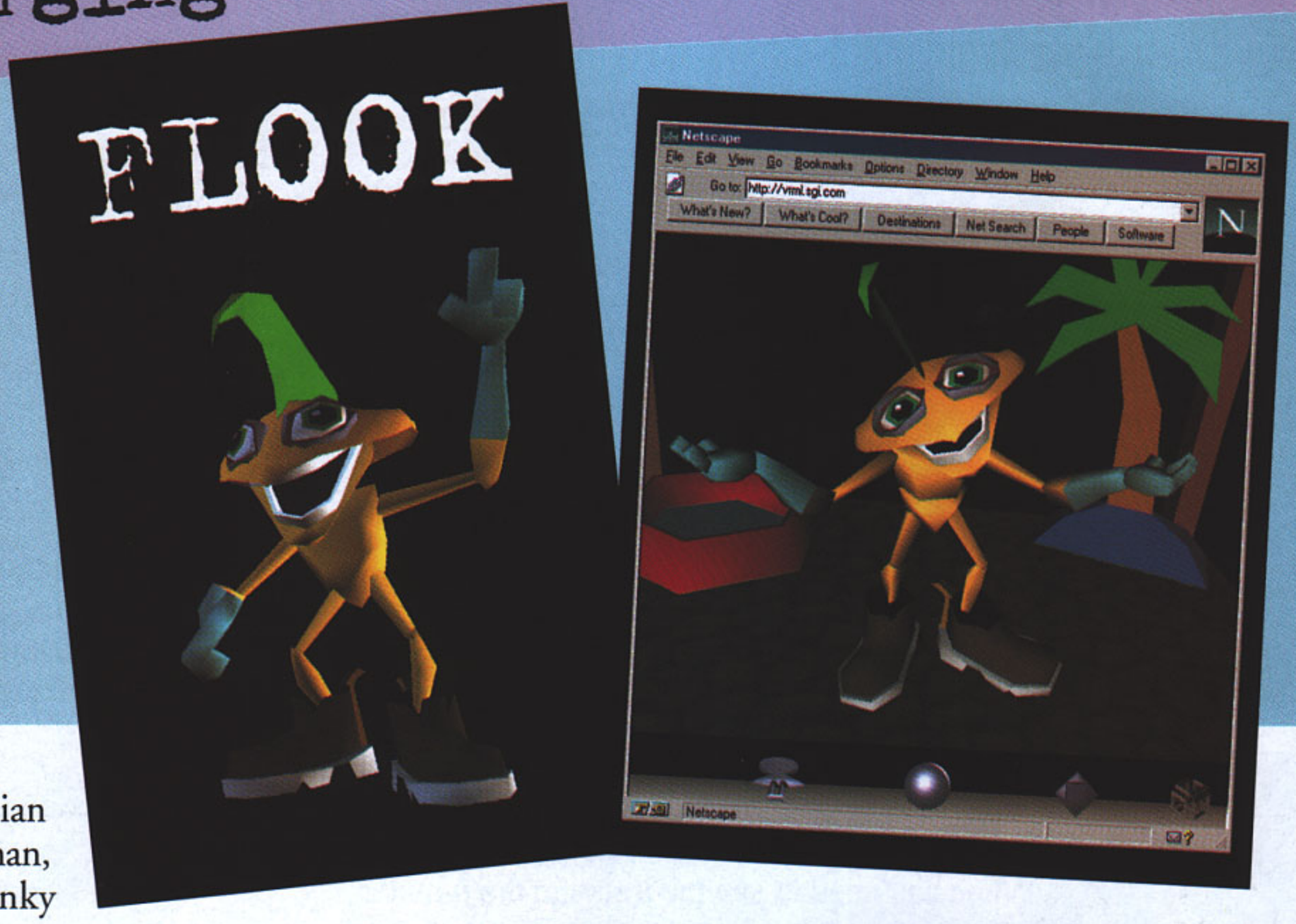
FLOOK:

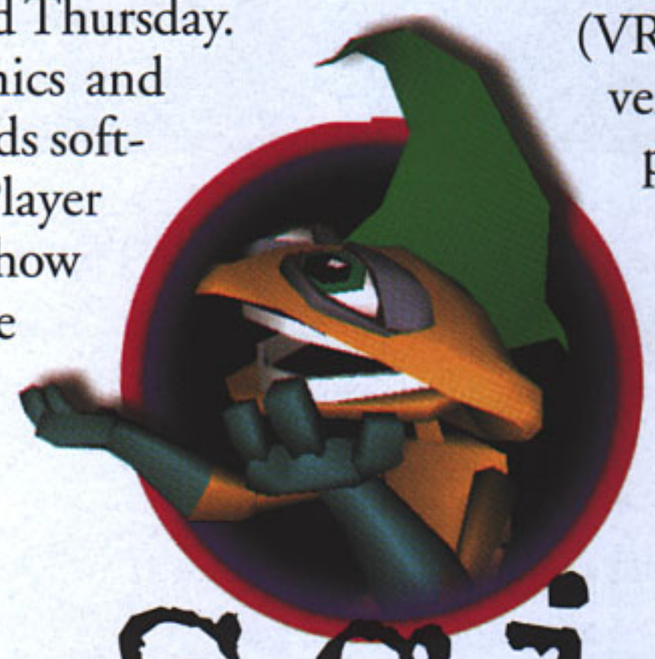
Bringing the Web to Life with VRML



Part amphibian and part human, he's got clunky brown boots, an outrageous green mohawk, and an attitude to match. He runs, spins, sings, and dances his way onto your computer screen. He's Flook—a prime example of how VRML can bring your Web site to life. Flook is starring in a new cartoon series, *Flook*, viewable on the Web with new episodes every Tuesday and Thursday.

Flook was created by Silicon Graphics and Protozoa using VRML and Cosmo Worlds software. It can be viewed through Cosmo Player software from Silicon Graphics. Find out how to download the software and view the *Flook* cartoon at: http://vrml.sgi.com.

"Flook is more than just an entertaining cartoon. He represents a single isolated example of the infinite applications possible using VRML 2.0," said Jan Mallis, executive producer for Protozoa, the co-creator of *Flook*.



Virtual Reality Modeling Language 2.0 (VRML) is an industry-standard universal description language for multi-participant simulation on the Web based on the Silicon Graphics-led "Moving Worlds" proposal, endorsed by more than 50 Internet-related companies.

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Let's Work Together

Let's Play Together!

by Linda Jacobson

We humans are social creatures. We enjoy doing things together. The fact is, we're interdependent. (Some of us are co-dependent, and if you think that's okay, so do I.) Perhaps our need for each other is the reason the Internet attracts us; it transforms our computers into community centers. The Web brings color, movement, and nonlinearity to the virtual community, while VRML adds a sense of space.

VRML-enhanced Web sites hint at how citizens soon may meet with each other inside virtual space via desktop computers. But right now, behind the scenes, folks are working in collaborative, immersive, simulation-based environments. By implementing high-bandwidth, low-latency connectivity, people in different places can interact with each other, with the same virtual models. This is fruitful and cost-effective for companies that want to resolve design decisions in real time, by having their geographically distant experts deal directly with a virtual prototype of a complex product.

While researchers at Lockheed Martin, NCSA, Fraunhofer, GMD, NTT, Argonne Labs, the University of Illinois Electronic Visualization Lab, Seattle's Human Interface Technology Lab, and Carnegie Mellon's SIMLAB, to name a few, push the edges of collaborative or networked VR, developers are building tools, vendors are selling products, and businesses are collaborating over distance to enhance productivity and make the most of their resources.

LEGO Toys R&D Director Dent-de-Lion "Dandi" du Midi is immersed in LEGO Virtual Village. Image courtesy of LEGO.

Here's an example: Bechtel, the engineering, architecture, and construction firm, has offices around the world. Bechtel has pioneered collaborative VR for conceptual engineering of international projects. For their expansion of Dubai International Airport in the Middle East, Bechtel engineers in San Francisco and London reviewed a design together: virtual Dubai airport, running on Division's dVISE toolkit and driven by Onyx RealityEngine2 supercomputers (one in each city), linked via ISDN phone line. Bechtel's manager of advanced visualization and VR, Coby Everdell, tells me, "The link between San Francisco and London costs seventy-five dollars per hour. There's just no comparison with the traditional cost and time involved in shipping models and people!"

A similar approach enhances professional playtime in Denmark. If you think the Bechtel engineers rejoice at avoiding

overseas travel, imagine the pleasure-in-progress inside the VR lab at LEGO, makers of the world's most popular toys.

Home of Scandinavia's largest computer graphics studio, LEGO has engaged in CAD engineering for many years. Today, the company uses a 3D graphics database of toy kit elements to manage its inventory and to develop content for cartoons, movies, future toys, and other intriguing projects.

Visionary artist Dent-de-Lion ("Dandi") du Midi is LEGO's director of R&D. His team uses the database with SmartScene, MultiGen's immersive 3D scene assembly package, to create LEGO Virtual Village, a networked collaborative play space. Dandi explains, "We're using a two-handed immersive interface because it's a better way to play with the data we work with." Instead of using networked VR to link people separated by distance, LEGO enables two designers in one lab, each wearing VR goggles, to play together in virtual space.

The designers enter LEGO Village after putting on their Virtual Research or n-Vision headmount displays and their Fakespace Pinch gloves, equipped with Polhemus or Ascension trackers. Inside, the designers access a virtual palette that provides hundreds of photo-realistic LEGO parts and textures. With a finger-tap, a designer picks any part; it appears in mid-air, ready to grab for building. The designers can grab "the fabric of space," as MultiGen dubs it, to navigate through the scene, shrink to LEGOman size, or swell to giant size to look over LEGOdom. After the scene is complete, the system generates a parts list. The designer can collect the appropriate plastic parts for assembling the plastic LEGO scene from the one created in the Virtual Village. If it looks great in physical reality, it could be ready for the toy store.

This approach to digital prototyping is supported by Onyx InfiniteReality. The supercomputer provides the juice necessary for real-time, collaborative interaction; real-time interactivity is requisite for a CG-based development tool for LEGO engineers. Kids play, after all, in real time. Besides the speedy graphics, fast system throughput, distributed simulation tools, and networking facilities of InfiniteReality, it supports stereo VR displays and 3D controllers right out of the box. The Performer and OpenGL APIs provide the foundation for MultiGen to harness the hardware's power, achieving hardware-based texture mapping, multisample anti-aliasing to prevent the dreaded "jaggies," and dynamic resolution to ensure steady frame rates, which are so vital for a sense of realism.

LEGO's system updates the display at a rate of 15 frames per second, drawn twice to achieve stereo. The Virtual Village is built from 120,000 photo-real polygons (20,000 of which are interactive and/or animated); 30,000 polygons appear in view at a time. LEGO uses all 64MB of texture memory to create a richly rendered scene. As a result, designers can make fast, creative decisions intuitively and in real time. Like kids play.

MultiGen's SmartScene allows collaborative, networked scene assembly, in which you use your hands to build and modify objects and to navigate through cyberspace.

Adults, like children, benefit from play with others. "We put our engineers in a shared space," Dandi says, "because we can learn from each other better. If we play in a shared space, we can do all the things with virtual LEGO that a kid can do playing with a friend. Next, we want to put multiple groups in a virtual world that stays perfectly synchronized, like military-type DIS (Distributed Interactive Simulation). This way someone in our design lab can work with someone in package design, so we can support nonsequential design production. If people in shared spaces can hand their work instantaneously to another person, that's nice! With collaborative VR, we lose boundaries between people and machine, between people and people, and between machine and machine."

If you're considering breaking any of those boundaries, keep this in mind: collaborative VR works on any Onyx or Onyx2 supercomputer, and on Indigo^2 Maximum IMPACT, but the machines at each end of the connection should provide the same performance specs. The sure way to keep the faster machine from overloading the other is to match each's ability to push polygons and textures. On the people side, keep this in mind: collaborative VR can radically improve a good working relationship, but it cannot fix a bad one.

If the working relationship is a good one, remember Dandi's motto: "Real time is real fun." And when work is fun, you get more done. ★

You can contact Linda Jacobson, VR evangelist, Silicon Graphics, at lindaj@sgi.com.

Relevant Web sites:
http://evlweb.eecs.uic.edu/EVL/RESEARCH/PAPERS/LEIGH/leightrans.html
http://www.division.com/cdrom/story.html
http://www.sc.ist.ucf.edu/~STDS/info.htm
http://www.lego.comhttp://www.multigen.com/smart.htm

Click Here to Interact with a Live Human

by Scott Rosenberg

The word "interactivity" means different things to different people. To me, it means e-mail—like the one I received last year from a flummoxed visitor to the Salon Web site:

> I tried repeatedly to register, but was told that every user name I proposed had already been taken. This includes the apparently very popular "kdrt3&&ee#" and "44fre))mmzt." Methinks something's wrong.

Here was a user who took an occasion of ear-smoking frustration with buggy technology (long since fixed, I promise!) as an opportunity for a small display of gentle sarcasm. It made my day. It reminded me that at the other end of the erratic Internet pipeline there sit actual human beings who can use the same pipeline to beam their woes and waggery back at us.

At the end of the day, true on-line interactivity is always a matter of people communicating with people, employing computers as filters, amplifiers, and accelerators. We speak of digital technology today as not only a tool but a medium—an extension of ourselves that we can use to talk and to tangle with one another.

Most software, in fact, is a communications medium, though the people at the other end may be hidden behind many layers of code. When you run Sound Toy, a music-making application for the Mac, you notice that its creator has changed the menu from "Quit" to "Stop This Thang." I consider this a satisfying encounter with the author; it gives me a little peek into his personality. But since Sound Toy comes on a CD-ROM, there was no easy way to tell him I liked his style. Until the popularization of the Internet, interactivity remained largely under shrink-wrap.

The World Wide Web was invented by a group of frighteningly intelligent physicists who wanted to share their research more efficiently. It was designed primarily as a publishing medium, with hyperlinks to collapse the distance between documents stored on widely scattered computers. The Web took off when Mosaic knit graphics into its dry textual fabric. It really exploded when people realized that what they were linking wasn't just their documents, but their minds—and that those links could forge a real-time, two-way connection.

Still, on the Web, interactivity is too often equated with pointless animation and push-button, "personalized" information delivery. By that standard, your TV set, with its full-motion video and fine remote-control interface, is a wonderfully interactive device. In the quest to make the Web resemble TV-type interactivity, an awful lot of processor power is being devoted to making banners pulsate and fly. When Macromedia introduced Shockwave, a remarkable tool for Web animation and multimedia, you could hardly call up a leading-edge home page without getting whacked by a rotating logo. Java, a potentially rich programming language, is widely and pointlessly employed today to bring CD-ROM-level complexity to the simple act of following links on a Web page.

Offering users the straightforward courtesy of an e-mail address on your home page is infinitely more important than lassoing their attention with an animated graphic. Yet how many Web sites still omit the former while highlighting the latter? Go to Pathfinder, Time Warner's megasite, and you're offered dozens of bewildering options—but nothing as simple as "e-mail us."

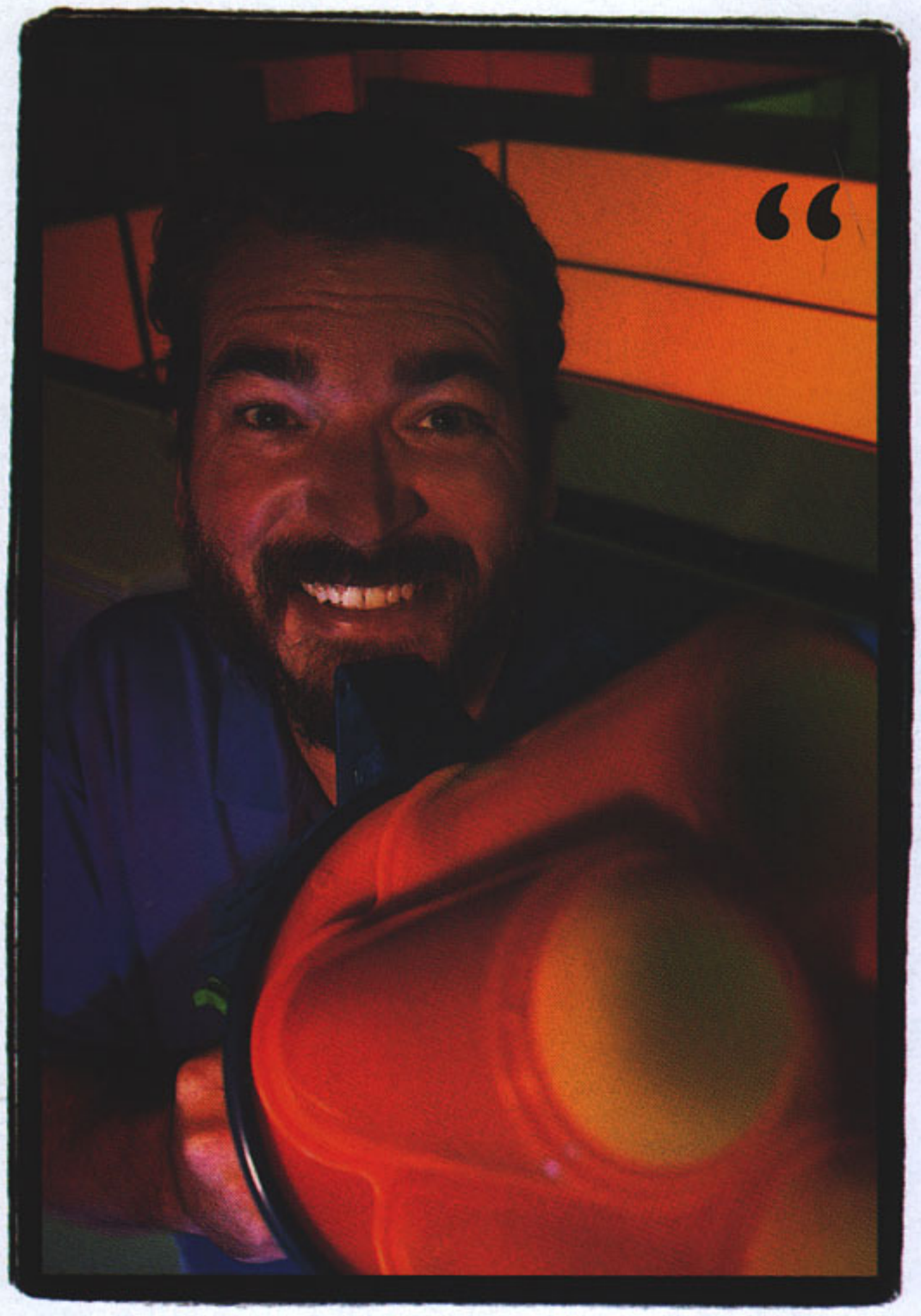
E-mail remains the lowest common denominator of interactivity; neglect it and you turn your Web site, in effect, into a sealed fortress. Still, e-mail just scratches the surface of what real Web interactivity can accomplish. As little as a year ago, Web-based bulletin boards and chat spaces were impossibly slow and cumbersome; today, they reliably provide many once barren and impersonal sites with a convivial new dimension. At gathering places like the *Utne Reader* site, Howard Rheingold's new Electric Minds or Salon's Table Talk (for which my hapless e-mail correspondent was trying to register), people are carving up the raw HTML pages of the Web into hospitable social spaces.

One of my favorite sites, Firefly, carries on-line shmoozing a step further—it registers your movie and music preferences and matches them with those provided by other users, creating a combination recommendation service and community-of-interest on the, er, fly. Like many commerce-oriented Web sites, Firefly plugs you into a database—not just to sell you stuff, but to hook you up with other people's passions.

Sooner or later, everything converges. On the Web, multimedia-style interactivity-with-flash will link up with community-style interactivity-with-heart. Quite possibly, they'll do so in 3D worlds based on VRML, which evolved out of the Silicon Graphics Open Inventor standard and is just beginning to spread across the Web. VRML 1.0 was a neat tool for building 3D spaces on line, but it was depressingly devoid of human presence—you always walked alone. The newer 2.0 spec allows for people to share these spaces using avatars as extensions of themselves; that may prompt a thousand worlds to bloom.

It's easy to imagine a Firefly-like service built around a VRML site, where people's on-line spaces are filled with their favorite sights and sounds, and where you're pointed toward people who share your enthusiasms. I'm sure somebody's already working on this; I expect to get e-mail about it any day now. ★

Scott Rosenberg (scottros@well.com) is senior editor at Salon *(www.salon1999.com).*



“because they rock,” and other technical reasons why Netscape uses Silicon Graphics WebFORCE servers, according to Webmaster Robert Andrews.

When you're the busiest site on the Web, when you receive more than 112 million hits a day, when you download 2.8 terabytes in a single week, you need servers that you can depend on. That's why Robert Andrews, Netscape's Webmaster, turned to Silicon Graphics. Our WebFORCE™ servers combine 64-bit MIPS® RISC microprocessors with the highest data throughput in the market. Our revolutionary S2MP™ system architecture, with industry-leading I/O, performance and scalability lets your Web site handle even the most demanding workloads. And since Silicon Graphics offers the widest range of compatible servers, you can scale your Web site smoothly as your on-line business grows. Technically speaking, it's the best server you can buy. And it can keep your Web site rockin'. For more information visit our Web site at www.sgi.com/Products/WebFORCE or call 800.636.8184 Dept. LS0054.

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Images courtesy of VisionArt Design & Animation

Jingle All the Way

by Ron Magid

Arnold Schwarzennegger has battled everything from evil aliens to shape-shifting robots. But in *Jingle All the Way*, he faces his toughest assignment ever, portraying a harried father attempting to locate the elusive Turboman action figure for his son on Christmas Eve, and combatting arch-rival Sinbad in his search for the last remaining toy.

Jingle All the Way's extensive visual effects were entrusted to VIFX and Visual Effects Supervisor Glen Neufeld. When Director Brian Levant (*The Flintstones*) decided to add several last-minute effects, Neufeld called in VisionArt, his Emmy Award-winning colleagues from *Deep Space Nine*, who had recently completed some 80 dogfight shots for *Independence Day* (*ID4*). VisionArt agreed to pick up about 20 shots for *Jingle All the Way*, involving what were supposed to be simple CG smoke and flame effects for Turboman's jetpack. "I don't usually do work for other houses," insists VisionArt's hands-on executive vice president, Josh Rose, "but I definitely wanted to work with Glen again, and we were using a similar pipeline, mainly involving Prisms (software)."

Using Silicon Graphics workstations, VisionArt started creating its effects for *Jingle All the Way* at the end of August, finishing them in under eight weeks. Despite the tight schedule, VisionArt created jetpack effects for two major sequences. Normally, VisionArt uses its own proprietary particle systems software, Sparky, for all fog, smoke, and fire elements, but on *Jingle All the Way*, the challenge was to exactly match VIFX's work. The problem: VIFX traditionally uses Renderman for rendering. VisionArt opted to use Side Effects' Prisms renderer Mantra, which they felt would be more compatible with Renderman.

"No matter how hard we push it," says Rose, "Prisms never stops, since it gives us the ability to write our own tools and plug-ins." Which is precisely what VisionArt's animators did to create the realistic flame and smoke emanating from Turboman's jetpack, perfectly matching their effects to those designed by Derek Spears and his VIFX team. "For *Jingle*, we used Prisms' particle system to generate the flame and the smoke, which were textured spheres."

Animation Supervisor Todd Boyce dealt with all the jetpack animation. After comping his effects over the jetpack in the plate, he'd send it on to paint artist Hilary Covey, who put the finishing touches on the photo-realistic effects. VisionArt's first jetpack

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shots are seen in the "episode" of the Turboman TV show, a ghastly parody of *The Mighty Morphin' Power Rangers*, which opens the film and introduces Turboman and his sidekick, Booster, a pink sabertooth tiger. Originally, VisionArt was only supposed to track and render flame and smoke to Turboman and Booster's jetpacks, which was relatively easy after matching VIFX's design. "We just expected to create this very graphic 3D flame and smoke, which was a pretty cool effect," Rose relates, "but then we had to do tons of paint and cleanup work. For example, a plate of Turboman flying through a window, shot from inside an apartment, featured an almost completely black foreground and a completely over-exposed background, so we had to comp our flame and fire going from a white sky to this dark interior. The cleanup on that required multiple color corrections and the flame adjustments, plus adding interactive lighting to the interior."

While VIFX handled most of the shots for the "TV show," VisionArt's quartet of shots involved some of the toughest effects in the film. In one scene Turboman jetpacks through a tree, splitting it in two, his vapor trail setting its branches on fire. This was filmed with a stunt Turboman flying on wires through the already split tree, whose nether branches belatedly flamed on. Although the wires had already been removed from the plate, VisionArt had to digitally repair the tree, then bust it apart as the stunt Turboman flew through. This required additional animation and cleanup work. To make the tree convincingly catch fire, VisionArt had to somehow connect the few anemic burning branches in the plate to the jetpack's exhaust. "We had to actually link up computer-generated (CG) photo-realistic fire from the jetpack to the existing production fire so the audience would understand the connection," Rose explains. "We added some additional CG branches so that when Turboman hit them, they snapped back into the wake of the jetpack, which sparked the production flames on the tree in the plate. We had to time it so that it looked like the backpack actually set the tree on fire. That ended up needing about fifteen CG elements."

VisionArt also handled six shots featuring close-ups of Arnold Schwarzennegger screaming in terror as he flies on a jetpack during the movie's climactic parade sequence, in which the dueling dads take their feud to the extreme level of a Turboman episode. Director Levant not only wanted to clearly see the jetpack's white-grey smoke trailing behind Arnold against the overexposed sky, he also wanted to see the flames behind the backpack. "That was a huge challenge," Rose says. "We had to totally cheat the perspective on the flame so it was visible behind the backpack, and print the smoke well over an overexposed sky! But it was fun for our guys to be able to work on an Arnold shot."

VisionArt continues in the wake of *ID4* with contributions to two other year end films: *Star Trek: First Contact* and *Daylight.*★

Ron Magid is special effects editor of American Cinematographer *and* Cinescape *magazines, a screenwriter, and a playwright.*

Silicon Graphics at AUTOFACT: Manufacturing in the Virtual World

AUTOFACT, an annual rite for manufacturers, is the premier showcase for computer technology in manufacturing. Leading-edge engineers and designers come from near and far to see the latest offerings from technology vendors. AUTOFACT '96 (Detroit, November 11–14) attracted more than 13,000 professionals to its exhibits and technical sessions—an outstanding opportunity for Silicon Graphics and its software partners.

The Silicon Graphics booth—open, airy, inviting, and 50 feet square—greeted visitors immediately as they entered the Cobo Center exhibit hall. All the major Silicon Graphics product families were exhibited: Indigo² IMPACT, Onyx, POWER CHALLENGE, and Cray (a T94, with cooling unit) were displayed alongside the recently launched O2 desktop workstations, Onyx2 InfiniteReality, and Origin servers. At AUTOFACT '96 Silicon Graphics featured SiliconWorks — the brand that represents Silicon Graphics' commitment to and focus on providing differentiated solutions to the manufacturing industry—solutions that dramatically impact and improve every aspect of the product development process, from concept to market.

Some 20 Silicon Graphics software partners (see sidebar) used workstations, servers, and supercomputers in the booth to demonstrate tightly integrated solutions, from design and analysis software to high-end visualization and virtual reality. These solutions, which included Alias|Wavefront, Pro/ENGINEER, CATIA, and SDRC, directly address the manufacturing industry's most challenging issues.

The overwhelming attraction in the booth was on the main stage. Every hour on the hour, the seats in front of the stage filled with exhibit-goers who came to experience a visit to the VRML world of a virtual manufacturing facility. Standees formed a wall of spectators behind them.

Silicon Graphics AUTOFACT '96 booth—ready for the doors to open.

"It was a really interesting demo," says SiliconWorks' Manda Mafy, "because it addressed the complete process that these companies have to go through. The VRML worlds made the format entertaining. But the message was very real, and talked to engineers in terms of their day-to-day work."

An on-stage demonstrator led the audience on a live walk-through, displayed behind her on a 16-monitor PowerWall. The display flew them through the engineering departments of a virtual automobile manufacturing facility: the conceptual design department, the engineering department, the design review room, the wind tunnel lab, and the shop floor. As the audience traveled through this virtual 3D world, it stopped to see live demonstrations such as an industrial designer working on a new car concept, engineers designing a drive train, the analysis team doing flow analysis, and a manufacturing engineer planning an assembly line. In virtual offices, they saw how Silicon Graphics WebFORCE tech-

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The MacNeal-Schwendler Corporation

Michael Schulman of Silicon Graphics is shown preparing demonstrations for the main stage presentation.

Graphics, animation, and VRML worlds were displayed on a 16-monitor PowerWall in the Silicon Graphics Booth.

nology is used by corporations to improve communication and decision making. They saw the Web used as a standard interface to multiple data formats.

As they passed through each department, clicking on a virtual workstation screen launched best-of-class applications from partners such as Parametric Technology, SDRC, and Dassault Systemes running on O2 and Indigo² IMPACT workstations. An Onyx2 Reality Engine system and a Cray server were used to demonstrate the benefits of design optimization using analysis applications and large model review technologies.

"It was quite a challenge for our people to switch the screen display back and forth between various systems," says Mafy, "but it was seamless to the audience. They saw lots of new technologies in 20 minutes."

Silicon Graphics software providers were extremely active at AUTOFACT '96. Alias|Wavefront demonstrated new releases of its 3D industrial design systems: Alias Studio 8.0, Autostudio 8.0, and Alias Designer 8.0. Together they provided new surface-evaluation technologies, productivity enhancements, and design process integration tools. Other providers also introduced innovative new features and packages.

"If there was any obvious trend this year over last year," says Joyce Kim of Silicon Graphics' Manufacturing Industries group, "it was the overwhelming presence of Web technology in the booths. Everywhere you turned, you couldn't escape it—whether you were viewing VRML models of assemblies, or managing documents on the Web, or programming in Java." This was true of the Silicon Graphics booth, where industry-leading WebFORCE technologies were being demonstrated.

The demonstrations were definitely not wasted on the people who attended AUTOFACT '96. When the conference ended, the attendees voted on what they had seen. They called Silicon Graphics' display the most technically informative presentation of all. *by Grant Ellis*

The Solution Group

Building Better Visual Simulation Solutions

In the past, many companies looking for high-performance virtual reality and visual simulation solutions for the Silicon Graphics platform had to develop their own applications from scratch.

Then came the introduction of Paradigm Simulation's Vega software. This innovative product provides a powerful real-time development tool for building 3D visual simulations applications for Silicon Graphics systems—making the creation of these high-performance applications much simpler and more cost-effective.

In 1994, Dallas-based Paradigm Simulation, a world leader in visual and audio simulation and virtual reality products for use on Silicon Graphics systems, founded The Solution Group, a consortium of companies that provides customers with complete simulation solutions. Its goal is to give customers more choices, less risk, an easier decision-making process, higher-quality products, and superior support.

"Customers can choose Solution Group products and not have to worry about the details of interfacing between them," says Bruce Caridi, vice president of sales and marketing for Paradigm Simulation.

"The Solution Group offers visual simulation and training solutions that share a compatibility standard. We ensure that these products work together," says Caridi. "The group also includes integrators who can provide total solutions custom-designed for each customer's needs."

Current Solution Group partners include Abba Technologies, Applied Data Technology, ATS Aerospace, Boston Dynamics, Glass Mountain Optics, Immersion Corp., IVEX Corp., Kaiser Electro-Optics, Mak Technologies, MultiGen, ObjectForm, Photon Simulations, Prosolvia Clarus AB, StereoGraphics Corp., Ternion Corp., Viewpoint Data Labs, Virtual Prototypes, Visidyne, and the Solution Group's parent, Paradigm Simulation.

The Solution Group leverages each partner's expertise to bring innovative real-time visual simulation and training tools to the marketplace, Caridi says.

Partners work closely together to develop new products. "Every time a new version of Vega comes out, for example, all the Solution Group partners will get an advance copy. They'll test their software with it. We, in turn, do a lot of testing in-house when a new Solution Group product is introduced," says Caridi. "Our engineering staff will study the new product and learn exactly what it does so that it can be integrated with other Solution Group products. Customer then know when they run these products on their Silicon Graphics system that they have been designed to work together."

The Solution Group targets the entire Silicon Graphics product line. "The requirements now are that you are within two revisions of the newest Silicon Graphics operating system, and that the customers have a current version of IRIS Performer, since all the products are built on top of IRIS Performer," says Caridi.

Solution Group products provide all the tools customers need to develop real-time simulation and training applications. The group provides tools and products for modeling and terrain generation, CAD conversion, off-the-shelf models, DIS networking, sensor simulation, real-time 3D visual simulation with audio, large area databases, marine simulation, motion models, force feedback input devices, collimators, head mount displays, force-level analysis simulation, integration services, and more.

Solution Group products can be purchased directly from a provider or via their respective distribution channels. Some Solution Group partners resell each others' products. The Solution Group is open to new members who demonstrate a commitment to providing innovative, integrated Solution Group-compatible applications, who bring added value to customers, and who are committed to establishing good working relationships.

To inquire about a specific Solution Group application, contact Bruce Caridi, vice president of sales and marketing for Paradigm Simulations at (972) 960-2301.

by Steve Geissen

Global Virtual Manufacturing '97

Global Virtual Manufacturing '97 (GVM '97) highlights the latest virtual reality, Web, graphics, and high-performance computing technologies used by manufacturing companies around the world for prototyping, preproduction engineering, and manufacturing—in short, the complete product development process, from concept to market.

To be held at the Westin Hotel, Detroit, Michigan, on March 19 and 20, GVM '97 will include speakers from industry, academia, and technology institutes, global status reports on virtual manufacturing implementations in Europe, Asia, and North America, and a trade show displaying the latest in virtual manufacturing technologies.

The conference and exhibition is targeted to executives and professionals in automotive, aerospace, consumer products, electronics, and other discrete manufacturing companies that are using or considering using these technologies to gain a competitive edge.

The event is cosponsored by EDS, which features a VR center near the GVM site in Detroit, *VR News*, the world's largest VR monthly magazine, the Engineering Society of Detroit, and Silicon Graphics, whose SiliconWorks initiative, which will be demonstrated at the show, focuses on how Silicon Graphics technologies help manufacturing companies develop better products, sooner.

Greg Laskaris of Local Knowledge Marketing is the exhibit sales manager for the event: (619) 294-3034. Carol Hallop is the conference co-chair: (313) 974-1657. ★

Determinant Tricks

by Tom Davis

In this column I'll derive some useful formulas for computer graphics based on the geometric interpretation of a determinant.

As usual, the results make sense in any number of dimensions, but we typically work with 1, 2, or 3. If I write "parallelogram" in the 2D case, you can think "line segment" or "parallelepiped" if you're wondering about the 1D or 3D version. Similarly, "triangle" translates to "line segment" or "tetrahedron" in 1D and 3D.

Figure 1 shows the relationships of lines, triangles, parallelograms, tetrahedra, and parallelepipeds determined by one, two, or three vectors in as many dimensions.

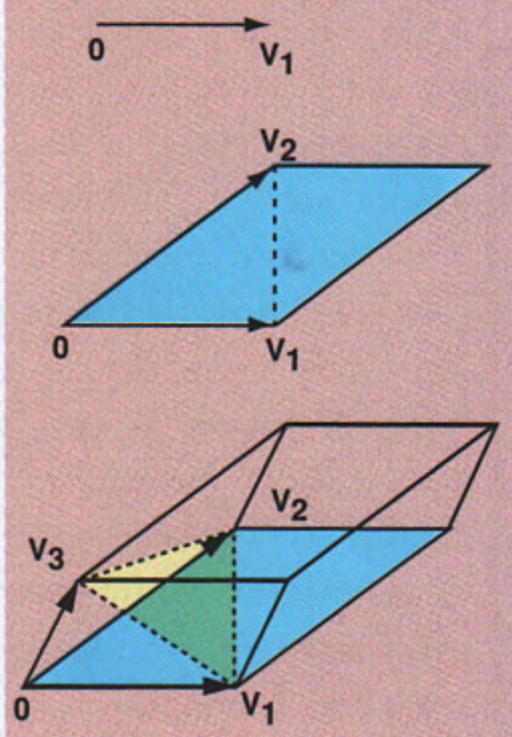

Fig. 1

In 2D, the determinant of a matrix composed of two vectors is the (signed) area of the corresponding parallelogram. "Signed," means that if the vectors are taken in the opposite order, the area is negated. For the triangle, this corresponds to a clockwise or counter-clockwise traversal. The absolute value of the determinant is the usual positive area.

A triangle connecting the origin to two vectors making triangle OV_1V_2 has area 1/2 of the value of the determinant. (In n dimensions, the factor is 1/n!) The line and tetrahedron in Figure 1 show why the factors of 1/1 or 1/6 (= 1/3!) are required in 1D and 3D. If the triangle doesn't happen to have one vertex at the origin, translate it so one vertex moves to the origin and continue as above. For example, the triangle {(1,2), (8,11), (3,7)} translates by (-1, -2) to {(0,0), (7,9), (2,5)}. The area is:

$$\frac{1}{2}\begin{vmatrix} 7 & 9 \\ 2 & 5 \end{vmatrix} = 1/2(35-18) = 17/2.$$

This can be expressed directly as a 3x3 determinant:

$$A = \frac{1}{2}\begin{vmatrix} x_0 & y_0 & 1 \\ x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \end{vmatrix}.$$

To see that this works, subtract the first row from the second and third to give:

$$A = \frac{1}{2}\begin{vmatrix} x_0 & y_0 & 1 \\ x_1-x_0 & y_1-y_0 & 0 \\ x_2-x_0 & y_2-y_0 & 0 \end{vmatrix}.$$

and expand by minors:

$$A = \frac{1}{2}\begin{vmatrix} x_1-x_0 & y_1-y_0 \\ x_2-x_0 & y_2-y_0 \end{vmatrix} = 1/2((x_1-x_0)(y_2-y_0) - x_2-x_0)(y_1-y_0)). \quad (2)$$

Figure 2 gives a geometric interpretation of equation (1). Adding a z-component of 1 to make three 3D vectors draws the triangle in the plane z=1. The 3x3 determinant represents 6 times the volume of a tetradedron of height 1 connecting the origin to the three vertices of the triangle. This volume is 1/3 times the area of the triangle times 1 (the height).

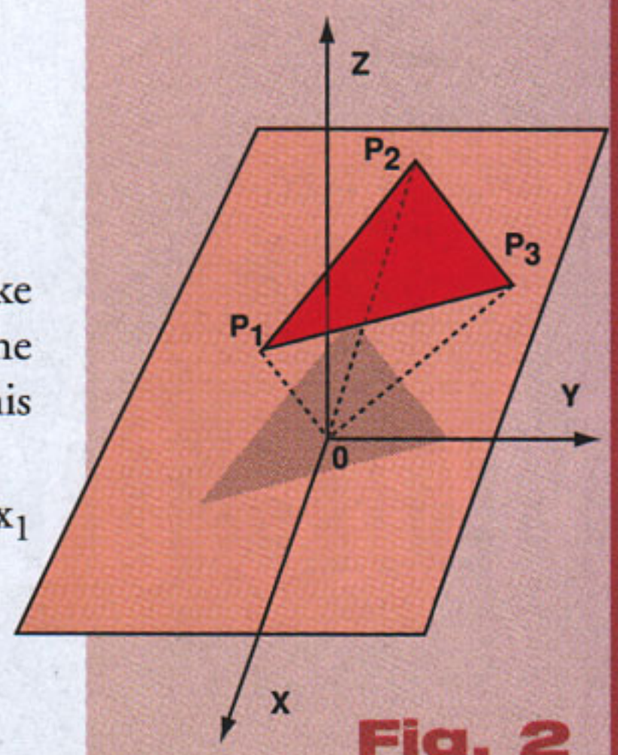

Fig. 2

Similar formulas work in 1D and 3D. In 1D, the (signed) length of a segment from x_0 to x_1 is given by:

$$L = \begin{vmatrix} x_0 & 1 \\ x_1 & 1 \end{vmatrix}.$$

and the (signed) volume of a tetrahedron having vertices (x_0,y_0,z_0) through (x_3,y_3,z_3) is given by:

$$V = \frac{1}{6}\begin{vmatrix} x_0 & y_0 & z_0 & 1 \\ x_1 & y_1 & z_1 & 1 \\ x_2 & y_2 & z_2 & 1 \\ x_3 & y_3 & z_3 & 1 \end{vmatrix}.$$

Formula (2) extends to give the area of any simple (but not necessarily convex) polygon. First expand the determinant for the area of a triangle:

$$A = \frac{1}{2}\,(x_0y_1 - x_1y_0 + x_1y_2 - y_2x_1 - x_2y_0 - y_2x_0)$$

From Figure 3 we see that the area of the quadrilateral is given by the sum of the areas of triangles $P_0P_1P_2$ and $P_0P_2P_3$:

$$A = \frac{1}{2}\,(x_0y_1 - x_1y_0 + x_1y_2 - y_2x_1 - x_2y_0 - y_2x_0)$$
$$+\frac{1}{2}\,(x_0y_2 - x_2y_0 + x_2y_3 - y_3x_2 + x_3y_0 - y_3x_0).$$

Four terms cancel, giving:

$$A = \frac{1}{2}\,(x_0y_1 - x_1y_0 + x_1y_2 - y_2x_1 + x_2y_3 - y_3x_2 + x_3y_0 - y_3x_0)$$

As triangles are added to the polygon, each additional triangle adds 6 terms but many terms cancel, and the area is:

$$A = \frac{1}{2}\sum_{i=0}^{n-1}\,(x_i\,y_{i+1} - y_i\,x_{i+1}).$$

where $x_n = x_0$ and $y_n = y_0$.

The formula works for nonconvex polygons because the determinant gives signed areas to triangles depending on their orientation.

Figure 4 shows how it works. Add the areas of $P_0P_1P_2$, $P_0P_2P_3$, and $P_0P_3P_4$. $P_0P_1P_2$ includes regions A, B, and C. $P_0P_2P_3$ includes regions B and C, but since it is traced in a clockwise direction, that area will be negative. Finally, $P_0P_3P_4$ includes regions C and D. The formula gives sum of these regions: (A+B+C)-(B+C)+(C+D) = A+C+D.

The same thing can be done to find a volume of an arbitrary polyhedron in 3D by breaking it down into tetrahedra with correct orientations. The formula, of course, is more complicated. ★

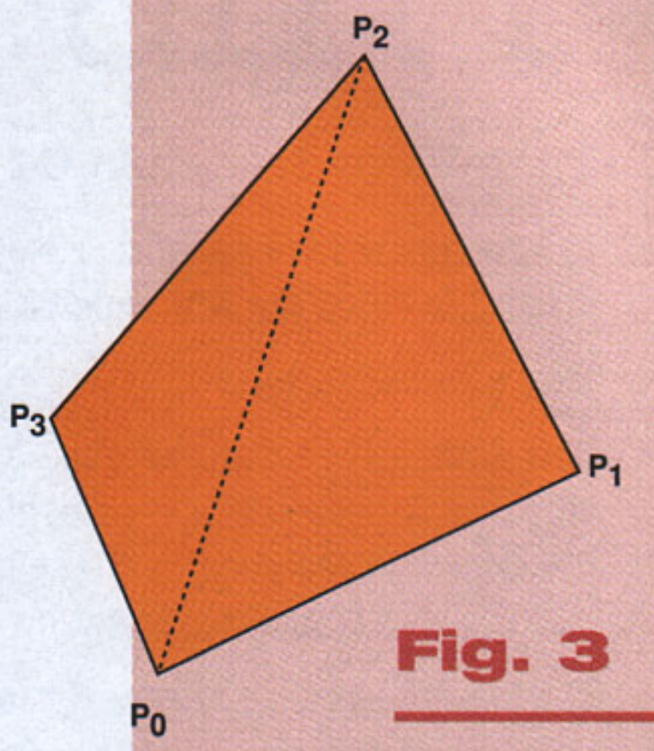

Fig. 3

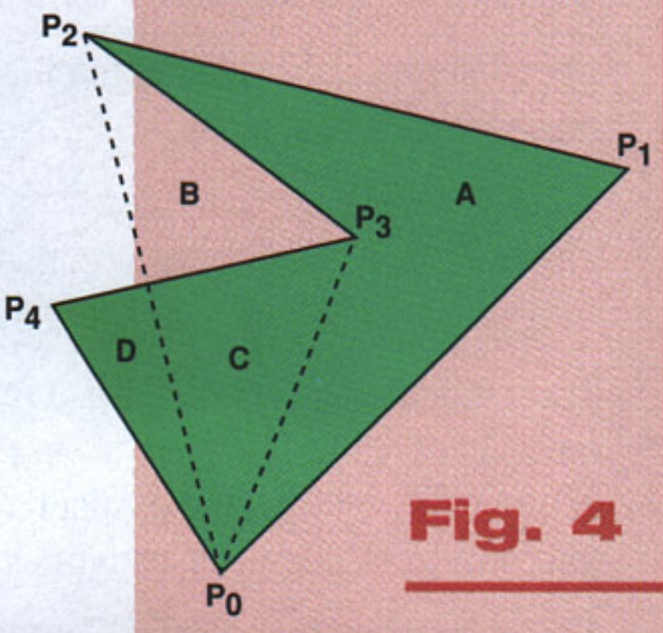

Fig. 4

Tom Davis (davis@asd.sgi.com) is a principal scientist at Silicon Graphics, where he works as a graphics hacker and mathematician-gone-bad.

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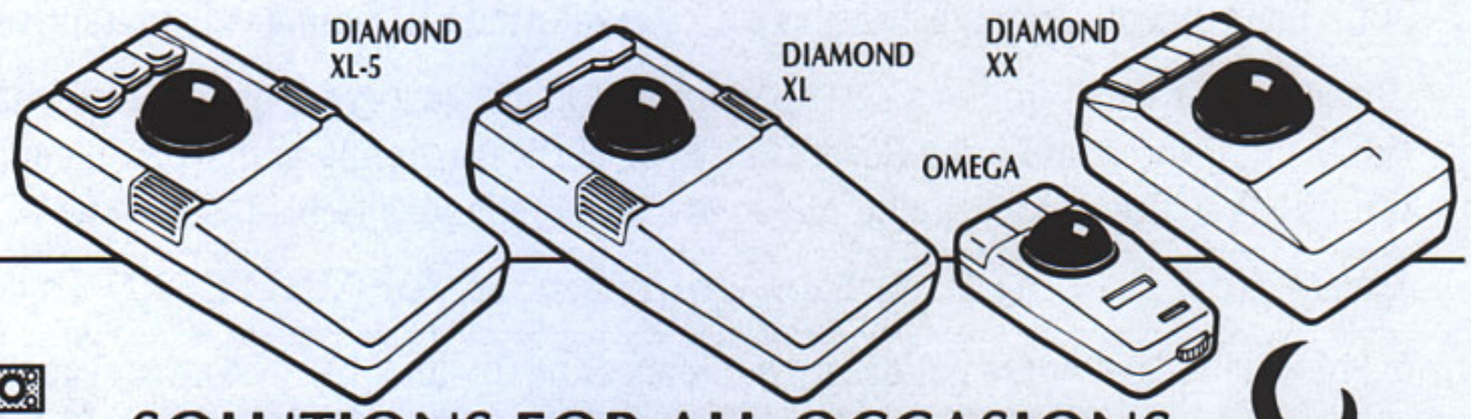

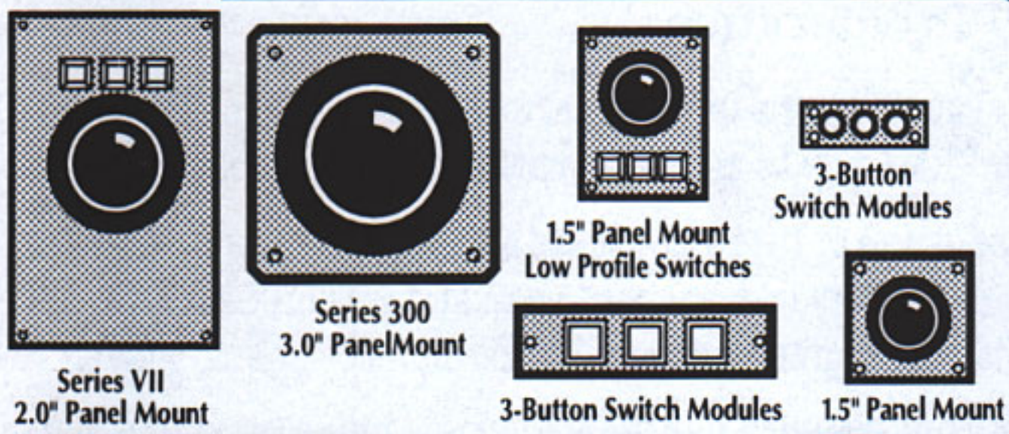

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This Just In...

Time Votes Nintendo 64 "1996 Machine of the Year"

In this hot year of consumer electronics, which included impressive desktop PCs, hand-held devices, and Internet hype, Time magazine voted the Nintendo 64 game machine the machine of the year.

Why a game machine?

The strongest reason (as quoted in Time): "The N64's greatest miracles come from a specially developed internal processing chip that does one thing—paint rich pictures on your TV—better than any other device in history. Called the Reality Co-Processor, the chip was designed by 3D special-effects giant Silicon Graphics and manufactured by NEC... who have stuffed the sophistication of a $10,000 workstation into a $200 box."

The second reason: "The most realistic and compelling 3D experience ever presented by a computer. Nintendo's smart-chip technology, blended with terrific software, has created a virtual world so compelling that the plastic game box moves from novelty to full-fledged revelation," said Time magazine.

Harley-Davidson Captures "Harley Roar"

Every motorcycle rider is familiar with the "roar of the Harley." With the help of Silicon Graphics technology, Harley Davidson has captured that roar.

"When people compare rides, they often refer to the 'roar of the Harley,'" said Alex Bozmoski, manager of Harley-Davidson's noise, vibration, and harshness engineering group. "We always knew that our sound was unique. Sound quality engineering and the Indy workstation provide solid evidence of that. The 'Harley Roar' is our trademark."

Trademark registrations are given to identifying symbols of a company, such as the sound of a Harley motorcycle. Harley engineers used an Indy workstation running Sound Quality Engineering analysis software from SDRC to analyze the famous engine sound made by Harley-Davidson motorcycles. The sound was digitized and loaded onto an Indy workstation to enable engineers to check for sharpness, roughness, frequency, and rhythm of the Harley Roar.

"Customers such as Harley-Davidson push whatever tools we give them," said Joe Dinucci, vice president of manufacturing industries for Silicon Graphics. "Like Harley-Davidson, we build products for the most demanding customers in the world, and can't wait for them to take our systems full-throttle."

Award-Winning Discovery Channel Online Harnesses Silicon Graphics Web Power

Using the power of WebFORCE CHALLENGE servers and Indy workstations from Silicon Graphics, the Discovery Channel Online (DCOL) Web site recently was awarded InfiNet's 1996 "Cool Site of the Year" and "Cool Design of the Year" based on its outstanding achievement in creating a Web site combining graphics and technical expertise into a unified and easily navigable experience.

DCOL uses Silicon Graphics servers and workstations to manage all content for the site.

"Discovery Channel Online's award-winning Web site is a great example of what can be accomplished by utilizing leading-edge Web technology," said Lenny Rosenthal, WebFORCE marketing manager, Silicon Graphics. "Silicon Graphics WebFORCE systems are unique in their ability to handle high-volume, complex Web sites such as Discovery Channel Online."

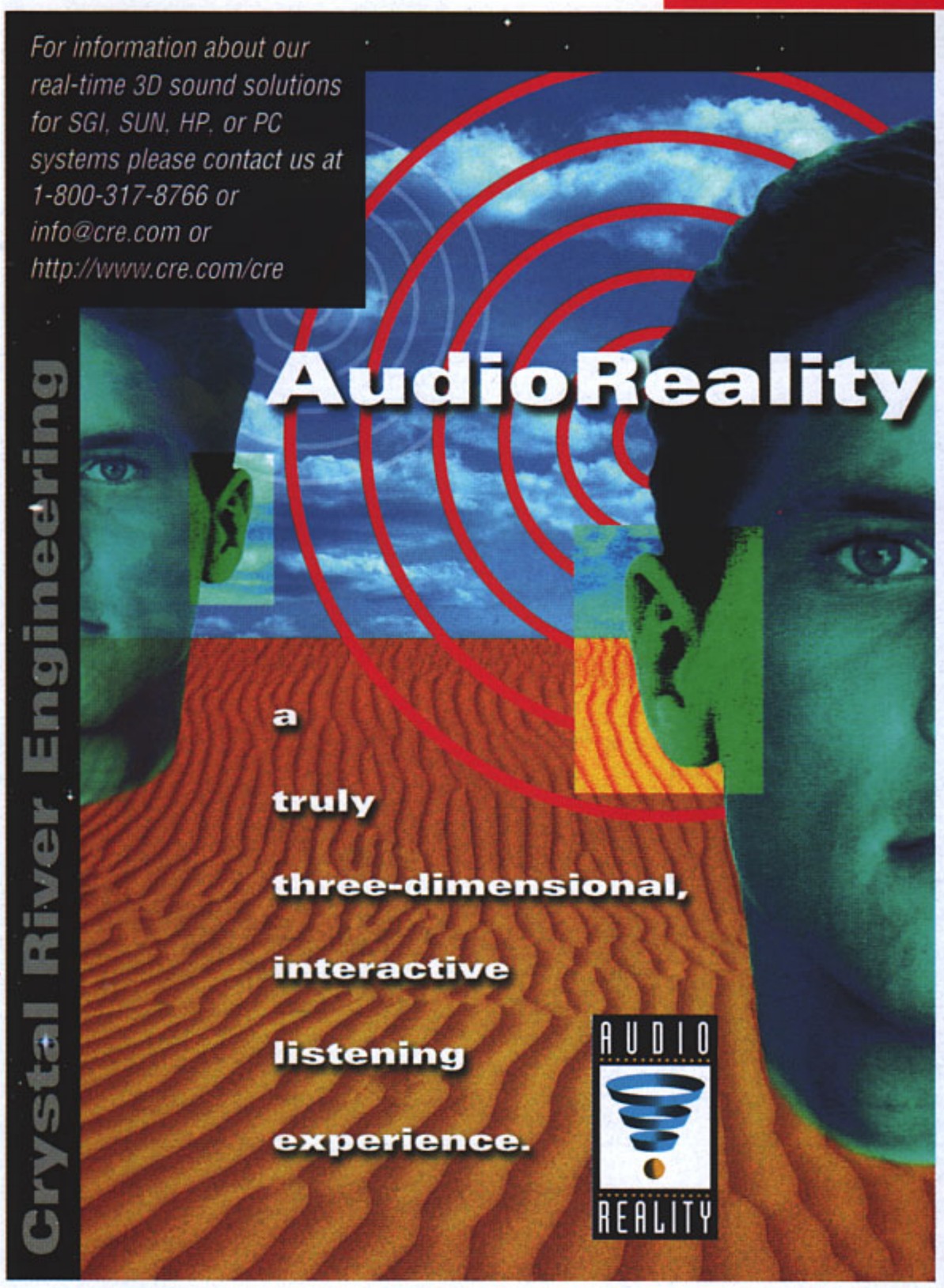
Apple and Silicon Graphics Join Forces for VRML 2.0 Proliferation

To enhance the networked interactive Internet and intranet 3D content and applications for high-performance, high-quality VRML browsing, Silicon Graphics and Apple announced a partnership to deliver VRML 2.0 to as many platforms as possible.

Apple will bundle the Cosmo Player VRML 2.0 browser with its "best of class" suite of Internet access software, the Apple Internet Connection Kit. Silicon Graphics plans to deliver the Mac OS version of Cosmo Player early next year, and Silicon Graphics will support Apple QuickDraw 3D as one of the rendering engines for the Windows 95 and Windows NT versions of Cosmo Player.

"In leading the development of the cross-platform VRML 2.0 standard, Silicon Graphics has started a new industry and initiated a transformation of the Web as we know it," said Larry Tesler, vice president of AppleNet Technologies for Apple Computer, Inc. "With Cosmo Player they have proven their commitment to delivering VRML to the broadest range of platforms and operating systems, which makes Silicon Graphics an ideal and logical company for Apple to partner with. Cosmo Player delivers unmatched 3D Web experiences, and we look forward to a close working relationship."

—by Eileen Tinney



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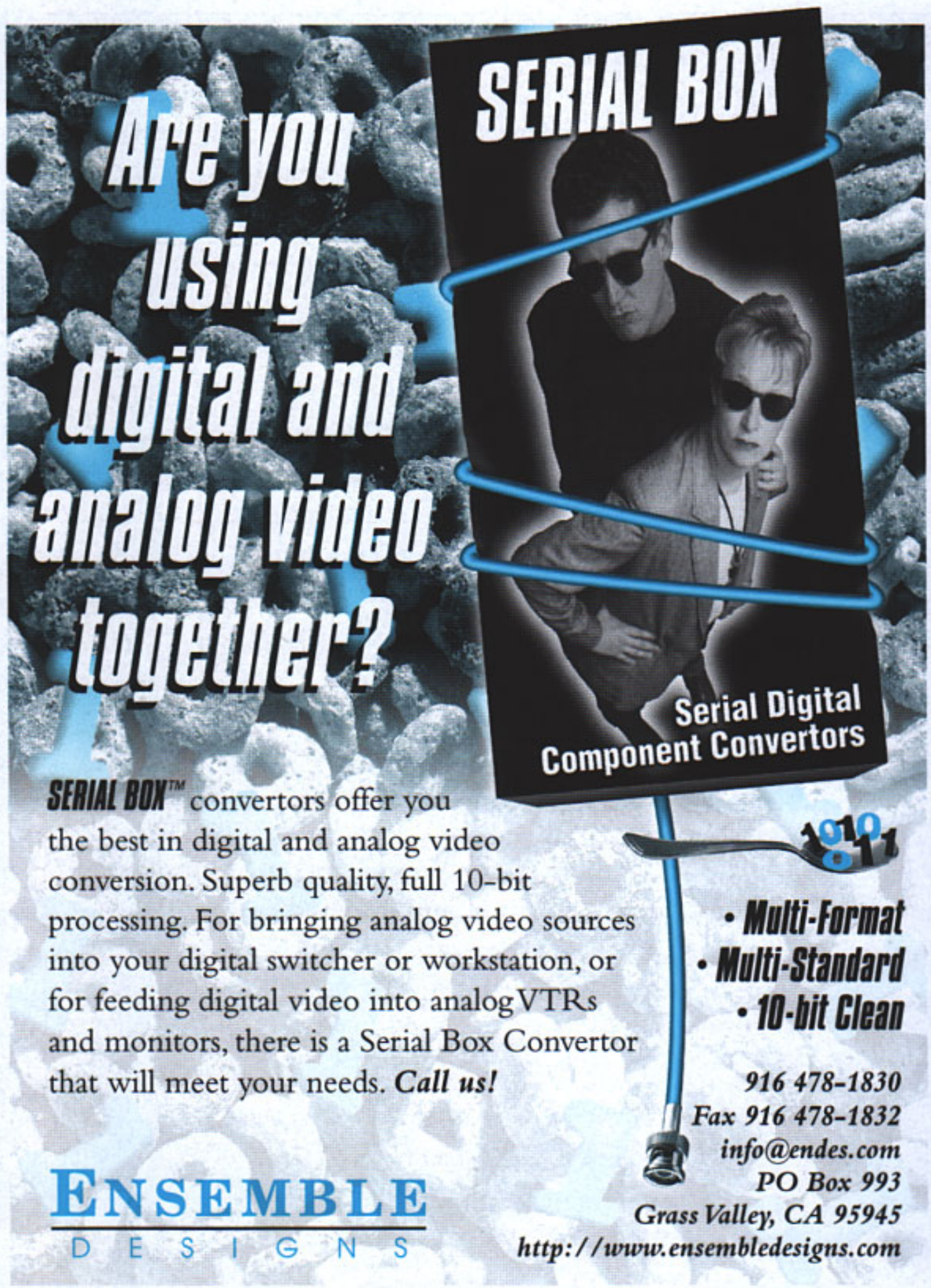

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January through March 1997	LOCATION*					
COURSE LISTINGS	**WEC**	**EEC**	**SEC**	**DEC**	**BEC**	**LAEC**
Advanced System Administration (4.5 days)	Jan 6 Jan 27 Feb 24 Mar 17	Jan 13 Mar 3	Jan 27 Mar 3 Mar 31	Feb 10 Mar 17	N/A	Feb 3 Mar 3 Mar 31
C Shell Programming (3.0 days)	Mar 10	N/A	N/A	Jan 13	Feb 17	N/A
Dynamic Web Programming (4.0 days)	Feb 10	N/A	N/A	N/A	N/A	N/A
IRIS Performer Programming 2.0 (4.5 days)	N/A	Feb 10	Mar 17	N/A	N/A	N/A
Introduction to IRIX (4.5 days)	Jan 13 Feb 3 Mar 3 Mar 24	Jan 6 Mar 3	Feb 10	Jan 13	Jan 27 Mar 17	Jan 27 Mar 10
Java w/Cosmo Code (4.5 days)	Mar 3	N/A	N/A	N/A	N/A	N/A
Network Administration (4.5 days)	Jan 13 Feb 3 Feb 24 Mar 17 Mar 31	Feb 27 Mar 17	Mar 17	Feb 3	Feb 24	N/A
ONYX Maintenance (9.5 days)	Jan 6 Mar 3	Jan 27 Mar 17	Feb 3	N/A	N/A	N/A
OpenGL Programming 1 (4.5 days)	Jan 27 Mar 17	Feb 3 Mar 31	N/A	N/A	Mar 10	Feb 24
OpenGL Programming 2 (4.5 days)	Feb 3	N/A	N/A	N/A	N/A	N/A
Open Inventor (4.5 days)	N/A	N/A	Mar 24	N/A	N/A	N/A
Parallel Programming (4.5 days)	Feb 24	Mar 31	Mar 10	N/A	N/A	N/A
ProDev C++ (4.5 days)	N/A	Mar 24	N/A	Feb 10	N/A	N/A
Real Time Programming (4.5 days)	Feb 10	Mar 10	Jan 13	N/A	N/A	N/A
System Administration (4.5 days)	Jan 6&27 Feb 10&24 Mar 10&24	Jan 13 Feb 10 Mar 10	Jan 13 Feb 24 Mar 31	Jan 27 Mar 3 Mar 24	Jan 6 Feb 3 Mar 31	Jan 13 Feb 10 Mar 17

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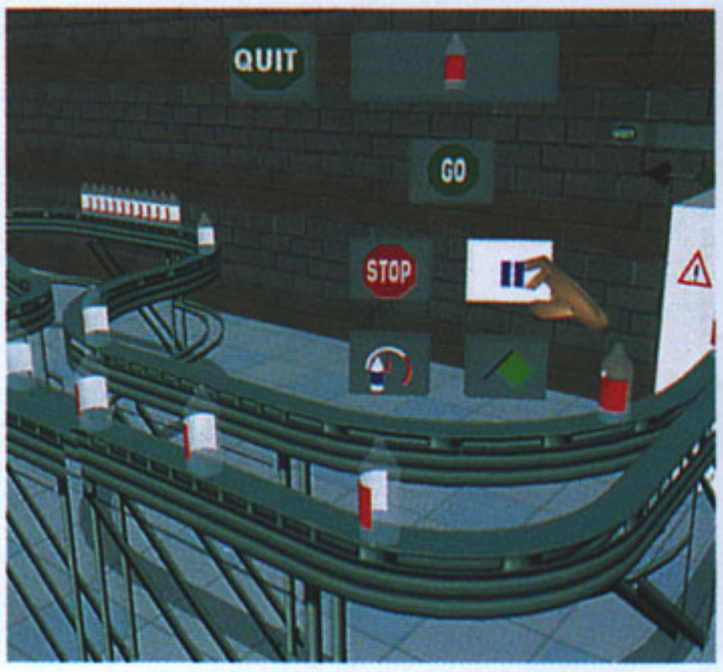

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